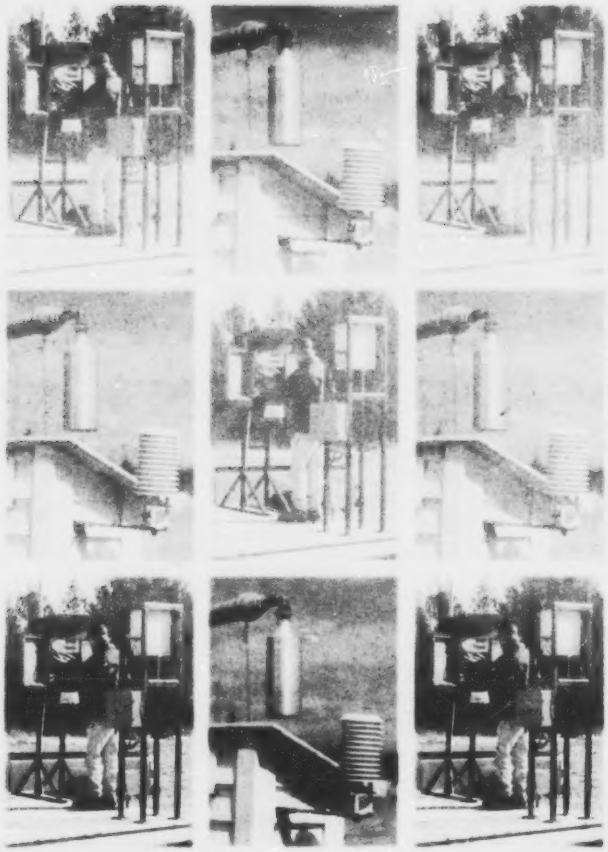
A REPORT ON

AIR QUALITY MONITORING RESULTS

IN NEW BRUNSWICK

FOR THE YEAR 1999



New Nouveau Brunswick
Environment and Local Government

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and Local Government

New Nouveau Brunswick

NEW BRUNSWICK

AIR QUALITY MONITORING RESULTS

FOR THE YEAR

1999

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Sciences and Reporting Branch
New Brunswick Department of the
Environment and Local Government
P.O. Box 6000
Fredericton
New Brunswick
E3B 5H1

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EXECUTIVE SUMMARY

This report summarises air quality monitoring data in New Brunswick for 1999. The report is intended to provide a convenient summary of air quality results for general public information, with emphasis on air quality assessment in relation to existing air quality standards and objectives. Long term trend data are also presented for representative sites. In New Brunswick, air quality standards for carbon monoxide, sulphur dioxide, hydrogen sulphide, nitrogen dioxide and total suspended particulate are specified in the *Air Quality Regulation* of the *Clean Air Act*.

Air quality has been monitored in New Brunswick since the 1960's, when several short-term studies were carried out in Saint John. The emphasis on air monitoring has steadily increased over the years. Air contaminants presently covered by provincial standards were measured at 54 sites in 8 regional monitoring networks across the province during 1999. Acid rain was measured at 13 additional sites. Inhalable particulate matter (PM_{10} and $PM_{2.5}$), ground-level ozone, volatile organic compounds (VOCs) and mercury in air and precipitation were also monitored at a number of locations, although no standards were in effect in New Brunswick for these substances in 1999.

This report presents summary statistics from all monitoring sites in the province, as well as additional statistical data (in chart form) in an Appendix.

The results in this report show that compliance with standards was generally good in 1999, with 100% compliance at many locations, and few sites having compliance rates of less than 95% of the total number of hours measured. Some variation in results is evident between regions and their monitoring networks. This variability is due to many factors including emissions trends, variations in industrial output, changing process or emission control technologies, and the weather conditions experienced in the year in question.

There were no exceedances in 1999 of standards for nitrogen dioxide or carbon monoxide at any of the provincial monitoring sites (seven sites for nitrogen dioxide and two for carbon monoxide). The total number of exceedances of sulphur dioxide standards in the province in 1999 was more than 45% below that in 1998. The number of provincial exceedances for hydrogen sulphide was similar to 1998, although significantly reduced in Saint John. Additional engineering controls are being implemented by REPAP in the Miramichi region, in an attempt to reduce the number of violations of the hydrogen sulphide standard.

Episode control programs, which are in effect for some major emission sources across New Brunswick, were seen to be effective in reducing the number of occasions on which elevated levels of air pollutants occur. Notable in this regard is the program in place in Saint John, which has enabled almost 100% compliance with a very strict ambient standard for sulphur dioxide. The Department of the Environment and local Government continually works with industries to implement the necessary control technologies to ensure compliance with air quality standards.

The number of ozone exceedances in 1999 was similar to 1998 (46, versus 42 in 1998). Air pollution due to particulate matter (TSP and PM_{10}) varied significantly between the various New Brunswick monitoring locations. Such variability is expected, as TSP and PM_{10} are both strongly influenced by local sources of particulate matter, including road dust and smoke from domestic woodstoves. Although the number of exceedances of provincial standards (or other nationally established objectives) was low at all monitored locations, it was generally greater than in the recent past. At several sites the annual averages for PM_{10} were the highest for more than 10 years. These increased levels are thought to be at least partly due to a high level of construction activity.

An examination of air quality trends at sites with long records indicates that since the late 1970s and 1980s, air quality has improved for all pollutants currently being measured, with the possible exception of ground level ozone. Levels of sulphur dioxide, total suspended particulate, and PM_{10} have fallen significantly over the past 15-20 years. Levels of carbon monoxide and nitrogen dioxide have also generally fallen. VOCs have also generally decreased since 1992, and potentially hazardous VOCs were found to be below guideline values recommended by other agencies.

Acid rain impacts continue to be of concern in the Province, particularly in southwestern districts. However, sulphate in precipitation, a key indicator of acid rain, has generally declined since the early 1990s, and in 1999 was close to the lowest level province-wide since organised monitoring began in the mid-1980s. Mercury in precipitation has fallen slightly since 1996. There was little evidence of any trend for mercury in ambient air over the same time period.

New Brunswick is continuing its active dialogue, information-sharing, data analysis and policy activities with neighbouring provinces and US states, to make further progress on both ground level ozone and acid rain abatement.

The management of air quality in New Brunswick is based upon the principles set out in the *Clean Air Act*. The Department's goal is full compliance with regulatory standards, and the prevention of degradation of air quality in the province.

Feedback

We are interested in your opinions and feedback on this report. All suggestions will be considered, and if possible, incorporated in future reports. You may contact the Sciences and Reporting Branch at (506) 457-4844, by fax at (506) 453-2265 or e-mail Robert Hughes at robert.hughes@gov.nb.ca with any comments.

Technical terms

Efforts have been made to keep the number of technical terms used in this report to a minimum. A list of common technical terms are defined or explained in a Glossary of Terms, which begins on page 72.

Report Authorship

Robert Hughes, Sciences and Reporting Branch: Text, data summaries and research.

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1. INTRODUCTION

This report summarises air quality information gathered during 1999 at monitoring locations across New Brunswick. A summary of data from the provincial acid rain network is also included. This report focusses on ambient (i.e. outdoor) air, which provides an indication of environmental quality in terms of air pollution. Some basic information on the emission of air contaminants is contained in section 9.

Air quality has been monitored in New Brunswick since the 1960's, when several short-term studies were carried out. A number of federal and provincial agencies were involved in these co-operative projects, including the N.B. Department of Health. The New Brunswick Department of the Environment was established in 1971. Following this, more routine air quality monitoring began in areas known to be affected by industrial emissions. The accompanying box details a number of significant events in the history of air quality assessment in the Province.

In 1973 the permitting provisions of the first *Air Quality Regulation* took effect, whereby facilities releasing contaminants to the environment could do so only in accordance with terms set out in an Approval to Operate.

AIR QUALITY MILESTONES IN NEW BRUNSWICK 1961-1979

DATE	EVENT
1961	Smoke and hydrogen sulphide monitoring carried out in Saint John by Transport Canada.
1964	Particulate pollution in Saint John studied by the Department of National Health and Welfare.
1970	Saint John District Medical Health Officer (DMHO) requested a federal study on air quality in the city.
1970	Dustfall and sulphur dioxide assessment began around the Belledune lead-zinc smelter.
1971	A five-week study of hydrogen sulphide, particulates and sulphur dioxide carried out in Saint John in response to the request of the DMHO.
1971	New Brunswick Department of Fisheries and Environment formed.
1971	Environment Canada, the federal environmental protection agency, established. The National Air Pollution Surveillance Network begins operation.
1971	New Brunswick *Clean Environment Act* entered force. National Air Quality Objectives proposed.
1973	The first provincial *Air Quality Regulation* enacted, including smoke density standards, a permit process for operations emitting air pollution, and limits on the sulphur content of fuel oils.
1974	Two-way catalytic converters required for new motor vehicles, to control carbon monoxide and hydrocarbon emissions.
1975	Extensive vegetation injury from air pollution seen in Saint John in July. Monitoring networks reviewed and improved.
1976	A computerised data collection system set up to gather data from air pollution monitors in Saint John.
1978	Air quality monitoring initiated around the Dalhousie thermal generating station.
1979	The issuing of a twice-daily air quality index system (Index of the Quality of the Air, or IQUA) began in Saint John.
1979	The *Air Quality Regulation* revised, with the inclusion of ambient air quality standards for the first time.

By the late 1970's, emphasis was also being placed on providing air quality monitoring information to the public. In 1979, an air quality index for public information was introduced in Saint John. The "IQUA" program - (Index of the Quality of the Air) was the first program of its kind to be operated in any Canadian municipality.

2. What's New

New in the provincial air report this year:

- details of continuous fine particulate data ($PM_{2.5}$) for Fredericton, Moncton, Saint John and St Andrews;
- Ambient air quality for Fredericton (CO, NO_2 and ozone);
- Monitoring results from sites operated by AV Cell Inc, in Atholville;
- Results from a newly-established site at Nackawic, operated by St Anne- Nackawic Pulp Company Ltd;
- a summary of volatile organic compound (VOC) measurements made in Saint John and at Point Lepreau since 1992;
- Results of monitoring at St Andrews for mercury in precipitation and air;
- Basic information about emissions of key air pollutants.

AIR QUALITY MILESTONES IN NEW BRUNSWICK 1980-1999

DATE	EVENT
1980	The IQUA index reached the very poor range during a serious episode in Saint John in late July and early August, featuring high levels of sulphur dioxide and ozone.
1980	Air quality monitoring started in Edmundston to assess the impact of the Fraser pulp mill.
1987	Three-way catalytic converters required on new motor vehicles, which reduce emissions of nitrogen oxides, as well as carbon monoxide and hydrocarbons.
1987	New Brunswick signs acid rain reduction agreement with Federal Government.
1988	Air quality monitoring established around the Grand Lake thermal generating station.
1989	Monitoring begun in Miramichi around the REPAP paper mill (then the MPPC mill).
1990	Leaded gasoline banned.
1991	Air quality monitoring started around the thermal generating station at Millbank and future site at Belledune.
1993	The provincial *Clean Air Strategy* released, outlining long term plans for air quality protection, enhancement and management.
1993	The smog advisory program (joint program with Environment Canada) began in southern counties of NB, providing public forecasts of high ozone levels.
1995	Air Resource Management Area (ARMA) Committee established in Saint John. The sulphur dioxide standard in Saint John, Kings and Charlotte counties reduced by 50%.
1996	ARMA committees established in Edmundston and Bathurst.
1997	ARMA committees set up in Dalhousie/Campbellton and Miramichi. *Clean Air Act* received government assent.
1997	IQUA issued in Saint John three times daily and available on the Internet. Daily forecasts of ground-level ozone released to the media for Fundy counties of southern New Brunswick (joint program with Environment Canada).
1997	*Clean Air Act* came into force on December 15.
1998	Air quality monitoring site established in Moncton.
1999	IQUA index available hourly via dial-in phone service in Moncton, Saint John and Fredericton. Daily ozone forecasting expanded to central and eastern New Brunswick

3. AIR QUALITY LEGISLATION IN NEW BRUNSWICK

The basic framework for air quality management in New Brunswick is provided by the 1997 *Clean Air Act*. This Act broadly specifies the areas and activities in which the Minister of the Environment has authority to make regulations.

In comparison to the *Clean Environment Act*, the *Clean Air Act* is more comprehensive and detailed legislation. It also places major emphasis on providing information to the public and encouraging opportunities for public involvement in decision-making.

Regulations are created under such Acts in accordance with the authority they provide, and set out the detailed requirements which must be followed by individuals or organisations who are subject to the legislation.

Since 1973, the *Air Quality Regulation* has been the Province's principal regulatory tool in this field and, with some recent revisions, it continues to apply under the *Clean Air Act*. It sets out detailed requirements and provisions for a wide range of air quality management issues. Provincial air quality standards have also been contained in this regulation since 1979.

Other regulations which are used to manage air quality cover issues such as Ozone Depleting Substances. As part of the more comprehensive *Clean Air Act*, additional regulations have been prepared, including the *Administrative Penalties Regulation* (which came into force in July 1998) and the *Public Participation Regulation* (under continuing development).

These new regulations are aimed at providing the Province with additional options to promote compliance, and formalising procedures for public review of Certificates of Approval for major emission sources, as well as the process of setting or revising air quality objectives for the Province.

The *Clean Air Act* and its associated regulations are intended for the management of outdoor air quality. Air quality in buildings is regulated by health legislation, including the *Health Act* and the *Occupational Health and Safety Act*.

4. NATIONAL AIR QUALITY STANDARDS AND OBJECTIVES

Air quality management in Canada is primarily a provincial responsibility, although the Federal Government has a key mandate to carry out monitoring and research, as well as manage air issues which have a trans-boundary or international component. An example is the long range movement of air pollutants across provincial or international boundaries, such as those which cause acidic precipitation and ground level ozone.

Canadian air quality objectives are developed by a national committee (the Working Group on Air Quality Objectives and Guidelines) which includes representation from federal and provincial health and environment officials. When finalised through the Working Group process, the resulting 'National Ambient Air Quality Objectives' are incorporated in federal legislation under the *Canadian Environmental Protection Act*.

The goal of this process is to ensure some degree of uniformity across the country. Provinces then have the opportunity to incorporate these national objectives in their own environmental legislation. A complete listing of Canada's existing National Air Quality Objectives is contained in Appendix II.

National Objectives cover the major air pollutants of concern. Individual provinces, however, are able to develop additional air quality objectives or guidelines, if deemed necessary for environmental management in their particular jurisdiction. An example of this would be New Brunswick's decision in 1995 to adopt ambient air quality standards for sulphur dioxide (SO_2) in the southern part of the Province (such as the one-hour level of 17 parts per hundred million), which are twice as stringent as the existing National Objectives for this substance.

Recently, a new system for environmental standard-setting has begun, under the guidance of the Canadian Council of Ministers of the Environment, a national body made up of environment Ministers from the federal, provincial, and territorial governments. This process aims to set "Canada Wide Standards" (CWS) for air, water, and possibly soils and sediments. The focus will be on setting environmental quality standards which are based on sound science, with the aid of stakeholder public input. Other aspects of the CWS process include a consideration of socio-economic and technical issues as the standards are determined, the incorporation of an implementation plan for each standard, and a commitment for public reporting on the achievement of the standards.

The National Working Group on Air Quality Objectives and Guidelines periodically reviews the latest scientific work dealing with the effects of pollutants on human health, and the environment in general. Based on these reviews, the existing National Air Quality Objectives are revised as required. New objectives may also be proposed.

With the exception of the objective for ground level ozone, New Brunswick has included all National Air Quality Objectives in its *Air Quality Regulation* since 1979. This action has the effect of giving such objectives legal status through the *Air Quality Regulation's* approval process.

In the case of pollutants such as ground level ozone, the management approach in New Brunswick involves reducing the precursor emissions wherever possible, together with concerted regional control efforts, since the majority of ground level ozone measured in New Brunswick originates in the north-eastern United States and, to a lesser extent, southern Ontario and Quebec. This involves federally-led negotiations with States and

Provinces which lie upwind from our western border. Precursor emissions are the substances which eventually lead to the formation of the pollutants themselves. For example, ground level ozone results from photo-chemical reactions in the air involving NOx (nitrogen oxides) and VOCs. In this case, NO_x and VOCs are precursors.

On a continental basis, New Brunswick's geographical position is downwind from some of the most heavily populated and industrialised regions of North America. This is why the Province's 1993 Clean Air Strategy has emphasised the need for a special focus on regional air quality management.

5. NEW BRUNSWICK AIR QUALITY STANDARDS

The New Brunswick *Air Quality Regulation* presently defines standards for five pollutants - carbon monoxide, nitrogen dioxide, sulphur dioxide, total suspended particulates and hydrogen sulphide. These numeric standards are indicated in the following table.

NEW BRUNSWICK AIR QUALITY STANDARDS

Pollutant	Averaging period			
	1 hour	8 hour	24 hour	1 year
Carbon monoxide	30 ppm	13 ppm		
Hydrogen Sulphide	11 ppb		3.5 ppb	
Nitrogen dioxide	210 ppb		105 ppb	52 ppb
Sulphur dioxide*	339 ppb (34 pphm)		113 ppb (11 pphm)	23 ppb (2.3 pphm)
Total suspended particulate			120 micrograms/m^3	70 micrograms/m^3

* The standards for sulphur dioxide are 50% lower in Saint John, Charlotte and Kings counties.

These figures are identical to Canada's National Air Quality Objectives, with the exception of the more stringent standards for sulphur dioxide in three southern N.B. counties, noted in the table above.

6. OTHER AMBIENT AIR QUALITY CRITERIA

A. Inhalable Particulate (PM_{10})

There are presently no National Objectives for PM_{10} in Canada. Some existing standards in other areas are shown in the following table. These standards (primarily those from the Greater Vancouver Regional District and the U.S.A.) are currently used as reference points for evaluation of any PM_{10} data gathered in NB. Note: Newfoundland also adopted a 24-hour objective of 25 micrograms per cubic metre for $PM_{2.5}$ in 1997.

PM_{10} Standards in Various Jurisdictions (micrograms per cubic metre)

Jurisdiction (date)	Averaging period	
	24-hour	1 year
GVRD (Vancouver) (1994)	50	30
Newfoundland (1997)	50	-
United States (1987; revised 1997)	150	50
California (1982)	50	30
Australia (1998)	50	-

B. Ground Level Ozone

As with PM_{10}, there is no New Brunswick standard in effect for ground level ozone. For evaluation purposes, the existing National Objectives for ozone are used as a reference and are shown in the following table. Additional information on the National Air Quality Objectives is contained in Appendix II. Note that New Brunswick is participating in the development of Canada-wide standards for both PM_{10}, $PM_{2.5}$, and ozone. In addition, New Brunswick is providing input for the development of an Ozone Annex to the Canada-US Air Quality Agreement. Work on this Annex began during 1999. The Annex is expected to formally recognise the geographic regions in Canada and the US where specific control measures must be applied to reduce ozone formation. It will also deal with emission caps or ceilings; technical limits on certain industrial processes; scientific work such as data sharing, mapping and interpretation, and data reporting. The development of this international policy document is seen as potentially useful in the continuing effort to obtain the required emission controls in regions upwind of New Brunswick.

National Ambient Air Quality Objectives for Ozone (ppb)			
Averaging period	Desirable Level	Acceptable Level	Tolerable Level
1 Hour	51	82	153
24 hours	15	25	-
Annual	-	15	-

Note: for an explanation of the different levels, see Appendix II.

7. AIR POLLUTANTS - THEIR SOURCES AND EFFECTS

Basic information is presented in the following sections about the pollutants covered by regulatory ambient standards in New Brunswick. The sources of such pollutants are also discussed, as well as their effects on human health and the environment.

A. Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas. Major sources include motor vehicles, home heating systems, and refuse burning. Outdoors, CO is generally a problem pollutant only in congested urban centres with high traffic density, especially in winter, as vehicle engines produce more pollution in cold weather. In some traffic conditions, drivers and passengers in vehicles may be exposed to higher levels of CO than pedestrians in city streets. Malfunctioning or badly-vented heating furnaces or stoves may also produce dangerous levels of CO in buildings.

If inhaled, CO quickly enters the blood stream, where it reduces the ability of the blood to deliver oxygen to the organs and tissues of the body. The health impact of CO is most serious for those who suffer from cardiovascular disease, although healthy individuals are also affected at higher concentrations. Exposure to elevated levels is associated with numerous symptoms, including headache, fatigue, nausea, and impairment of vision. Work capacity, learning ability and the ability to perform complex tasks are reduced (Stewart, 1975; USEPA, 1980; Ritchie, 1991; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1994; 1998).

B. Nitrogen Dioxide

Nitrogen dioxide (NO_2) in high concentrations is a reddish gas with a sharp, pungent smell. It is corrosive and can assist the start and spread of fire. Most NO_2 found in the outdoor environment is not the result of direct emissions. Instead, it forms from nitric oxide (NO), which is emitted by many combustion sources, especially those which operate at high temperatures and pressures.

Motor vehicle engines meet both these characteristics, and are a major source of NO, which reacts quite rapidly with ozone in the air to form NO_2. Collectively, NO and NO_2 are often referred to as nitrogen oxides or NO_x. Thermal electricity generating stations and large heating boilers are other major sources of NO_x.

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection. It also has an adverse effect on materials (e.g. corrosion of metals, fading of fabric dyes, degradation of rubber, etc.) and can damage vegetation (CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1987a).

As noted earlier, NO_2 also plays an important role in the formation of ground-level ozone, by reacting with hydrocarbons in the presence of sunlight, and contributes to the formation of acid rain and visibility-reducing haze, or smog.

C. Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a characteristic smell, like that of a struck match. When levels reach between 0.3 to 1.0 parts per million (ppm), it is generally detectable as an acidic taste in the air. SO_2 dissolves very readily in water, eventually forming sulphuric acid. SO_2 is one of the most significant pollutants in many industrialised nations: it is often emitted as a result of burning sulphur-containing fuels, and by metal smelters and oil refineries. Emissions of SO_2 from motor vehicles are relatively minor.

Health effects associated with exposure to high concentrations of sulphur dioxide include breathing discomfort, respiratory illness, alterations in the lung's normal defences, and aggravation of existing respiratory and cardiovascular disease. People with asthma, chronic lung or heart disease are the most sensitive to SO_2. Apart from effects on human health, SO_2 can also directly damage the leaves of trees, and agricultural crops. (Environment Canada, 1985; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1987b). SO_2 also has important indirect impacts by contributing to acid rain, which acidifies lakes and rivers, speeds up the corrosion of masonry and metal objects, and removes essential elements from the soil. Sulphur dioxide also contributes to the formation of acid aerosols (fine acidic particles), which may have detrimental health effects. These small particles cause a visual haze, which affects the enjoyment of scenic vistas and has an effect on the earth's radiation balance.

D. Hydrogen Sulphide

Hydrogen sulphide (H_2S) is a colourless gas with a characteristic smell of rotten eggs. H_2S is flammable and can form an explosive mixture with air or oxygen. Common sources of H_2S include pulp and paper mills, oil refineries, steel processing plants, natural gas plants, and sewage treatment systems. Natural sources include sulphurous hot springs and volcanic vents, swamps and bogs. Naturally-occurring sulphate-reducing bacteria can also produce H_2S in domestic water systems. The processes which produce hydrogen sulphide often generate other sulphur-containing compounds, such as methyl mercaptan and dimethylsulphide. These substances are also highly malodorous, and are often grouped together with hydrogen sulphide and referred to as total reduced sulphur compounds, or TRS.

In the ambient air, the undesirable effects of H_2S are generally felt in terms of a bad odour. The odour threshold for H_2S is generally 1-5 ppb, but can be lower for some individuals. There is some evidence that persistent exposure to unpleasant odours may have an significant effect on community health: review and monitoring of relevant health studies continues.

At higher concentrations (from 2 to approximately 100 ppm) hydrogen sulphide affects the mucous membranes, causing eye and throat irritation. Above this level H_2S becomes life-threatening as the sense of smell is impaired, removing the body's normal warning signal.

High concentrations of hydrogen sulphide can also cause paint discoloration and metal corrosion, and are damaging to plants (Environment Canada, 1984; Masters, 1997). Life-threatening levels, in excess of 300 ppm, can exist in underground sewer pipe systems and occasionally above ground near sewer manholes, in situations where sewer gases are released from underground piping. During drilling for oil and gas, blow-outs can also occur with the release of large quantities of H_2S.

Ambient concentrations in New Brunswick, even in the vicinity of large emission sources, seldom exceed 40 ppb (0.04 ppm).

E. Ground-Level Ozone

Ozone (O_3) is a reactive, unstable form of oxygen. In very high concentrations, it is a bluish gas. The characteristic sharp smell of ozone may be recognised around electrical equipment such as motors or arc welders, where it is formed by the high temperature electric spark. In the concentrations found in outdoor air, even in the most severe pollution episodes, ozone is both colourless and odourless. Ozone is not emitted directly from smokestacks and exhaust pipes, but is formed in the air from other pollutants, most importantly nitrogen oxides (NO_2) and hydrocarbons or VOCs (such as solvent and gasoline vapours).

Vehicle exhaust contains all the necessary compounds to produce ozone, and, as a result, cars and trucks are important contributors to ground level ozone concentrations. Industrial emissions of NO_x and hydrocarbons are also significant precursor emissions for ground level ozone.

Slow-moving air and strong sunshine greatly speed up the formation of ozone. As a result, ground level ozone is not typically a problem pollutant in the cooler months, but is likely to be more significant in hot, hazy summer weather. Such haze may build up over a period of days into a "photochemical smog". However, the yellow or brownish colour of such smog is usually due to nitrogen dioxide and fine chemical particles, not the ground level ozone itself.

Because the formation of ground level ozone depends on weather conditions, the severity of ozone pollution can be very variable from one year to the next. In New Brunswick, significant ozone episodes occur on average about six times per summer, mainly affecting the southern part of the province. Much of this ozone originates from populated regions of the north-eastern United States, especially the Washington to Boston "corridor".

Ground-level ozone irritates the lungs and can make breathing difficult. Exposure to high concentrations can result in chest tightness, coughing and wheezing. Recent health research suggests there is no threshold concentration below which ozone does not affect human health. Ground level ozone can cause damage to agricultural crops which are ozone-sensitive, such as potatoes and tomatoes. It can also cause noticeable leaf damage in other species. Forest trees and other vegetation may be injured, or growth inhibited. Ozone also weakens rubber, and attacks metals and painted surfaces (Bates, 1980; Multistakeholder NOx/VOC Science Program, 1997c).

Ozone levels are often lower in city centres than in surrounding rural areas. This is because ozone reacts with nitrogen oxides, often found in relatively high concentrations in city cores due to emissions from motor vehicles. This effect is seen in Saint John, although to a lesser extent than in larger cities. A separate network of sites exists to assess rural ozone. The results from that network are discussed later in this report.

F. Total Suspended Particulate (TSP)

Particles in the air (also called "particulates" by air pollution scientists) may either be of natural origin or the result of human activity. Some common natural sources and types of particulates include wind-blown soil dust, forest fires, sea salt, volcanoes, and plants (which produce pollen and spores). Human activities which generate particles include fuel combustion (domestic and industrial) and any other burning (e.g. waste incineration or slash burning); travel on dirt roads, construction work, and mining and quarrying. Dust on road and work sites is often wetted down to control particulate emissions. Other kinds of particles form in the air when gases such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) react together. These particles are partly responsible for the yellowish "smog" sometimes seen over large cities.

TERMS USED TO DESCRIBE PARTICLES AND HAZE

TSP: Total suspended particulates. A measure of particle concentration determined with a high-volume air sampler, which draws air through a filter over a 24-hour period. Includes particles with a wide range of sizes, up to 25-45 microns in diameter. TSP is normally measured on a nationally-standardised one-in-six day cycle.

PM_{10}: Particulate matter with an effective diameter of 10 microns or less. Also termed "inhalable particulates", as particles of this size are small enough to be inhaled via the mouth and some may enter the lungs.

$PM_{2.5}$: Particulate matter with an effective diameter of 2.5 microns or less, which bypasses filtration in the nose and may be deposited in the lungs. Also referred to as "respirable" particulate.

CoH: Coefficient of Haze. A relative measure of particle concentration determined by drawing air through a paper tape and measuring the change in light transmission of the tape.

Particles, particulates, aerosols: When referring to air quality, these terms are interchangeable, and refer to particles small enough to be transported some distance through the air. Most of these are less than 40 microns in diameter (roughly the size of pollen grains).

Fine particles: Particles with an effective diameter between 0.01 and 2 microns. Most particles forming as a result of industrial processes and combustion (natural or man made) are in this size range. Sometimes loosely used to refer to $PM_{2.5}$. Includes smoke particles.

Coarse particles: Particles with an effective diameter between 2 and 100 microns; includes PM_{10}. Much of the coarse particle load in the atmosphere is of natural (crustal) origin. Also includes pollen and spores.

"Total suspended particulate" (TSP) has been a standard pollution measurement for many years, obtained by drawing a large volume of air through a special filter. This method makes no distinction between natural particles, such as pollen and spores, and particles which are emitted from vehicles or smokestacks.

People with existing breathing complaints such as asthma, bronchitis or emphysema, are liable to be adversely affected by high concentrations of particulates (Wilson and Spengler, 1996; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1998).

Particulates can also cause corrosion and soiling of metalwork or other materials, damage vegetation, and reduce visibility.

G. Inhalable Particulate (PM_{10})

Particles smaller than 10 microns (a micron is a millionth of a metre, or a thousandth of a millimetre) are called PM_{10}, and are not filtered out of the air by the nose, throat and upper windpipe. As a result, these very small particles can enter the lungs where they may irritate or otherwise have an adverse effect on the delicate membranes and air sacs which absorb oxygen. Other toxic effects may occur, depending on the chemical make up of the fine particles. Because they can enter the lungs, PM_{10} particles are sometimes referred to as 'inhalable' particles, and are measured separately from TSP.

A number of recently published health studies have concluded that lung function, cardio-respiratory mortality, respiratory illness-related hospital admissions, and a variety of other health factors are related to ambient concentrations of PM_{10}. However, which particular aspect of the fine particles is causing these effects has not yet been fully resolved. Particle chemistry, and possibly acidity, may be important. As for ozone, there appears to be no lower concentration threshold below which health effects are not observed. Recent studies also suggest that particles have effects on the immune system (Wilson and Spengler, 1996; Blomberg, 1998).

In Canada, only the Greater Vancouver Regional District (GVRD) and the province of Newfoundland have a standard in place for PM_{10}, although work on developing a national objective is currently under way. In the United States, standards exist both nationally and in California, which has the same standard as the GVRD (see table on page 6).

H. $PM_{2.5}$

Another standard specification for measuring particulates is $PM_{2.5}$, which refers to particles equal to or smaller than 2.5 microns in size. These particles are thought to be of special significance in terms of health impacts, as they have a higher chance of entering and remaining in the lungs if inhaled, compared to PM_{10} or larger particles. They are sometimes referred to as 'respirable particles'.

New particle monitoring technologies have been introduced in recent years which allow the continuous measurement of PM_{10} or $PM_{2.5}$. An example is the TEOM monitor. These units provide continuous, unattended recording and electronic logging and reporting functions. These units are now installed and operating in Saint John, Fredericton, Bathurst, Moncton, and St. Andrews.

I. Volatile Organic Compounds

VOCs are carbon-containing substances which are present in the air in gas form, usually at low concentrations (in the parts per billion range).

Thousands of different VOCs exist in the air. However, many VOCs are of natural origin, and in terms of environmental protection, the VOCs which cause some kind of problem are most important. Everyday examples of VOCs which may be a concern in the environment include gasoline and organic solvents. Other products such as paint, adhesives, and a variety of other household goods may contain solvents which evaporate and contribute to the VOC content of the air. VOCs are also emitted by a wide range of industrial sources, as well as by motor vehicles. Vehicles emit VOCs in their exhaust, and from fuel tanks. Modern vehicles have systems in place to minimize such emissions, but overall, transport-related emissions are still substantial. A large number of VOCs can be emitted by industrial processes (for example by the petrochemicals or plastics industries).

Some VOCs may be potentially toxic to humans, animals or vegetation (e.g. benzene, 1,3 butadiene, ethylene) or are of concern because they can react in the air to form other harmful substances. For example, ethylene and propylene (and many other VOCs) may take part in reactions which lead to the formation of ozone-containing smog. Some VOCs may contribute to undesirable odours, such as various petroleum hydrocarbons.

The VOC sampling program in New Brunswick concentrates on about 150 compounds which are of special interest, including known and suspected carcinogens such as benzene and 1,3 butadiene, and photochemically active VOCs which contribute to smog formation.

8. MONITORING NETWORKS

Compliance with air quality objectives or regulatory standards is determined by monitoring. Because exposure to many air pollutants can occur at any time, most are monitored continuously, although particulates have been an exception. However, new technology now allows continuous measurement. As a result, continuous particulate measurements are gradually becoming more widespread and available.

Monitoring locations are selected so that they will provide information which is representative of the surrounding area. In cases where there is a known pollutant source, monitors are often distributed around it in locations where the impact is expected to be greatest. Such locations are typically selected based on the results of computer dispersion models. These are computer programs which simulate the behaviour of plumes, or discharge streams of gases as they are released from smokestacks. Such models take into account the complete variety of weather conditions which may be experienced in the area where the stack is located, as well as the nature of the local landscape.

In New Brunswick, large industrial emission sources, such as electricity generating stations or pulp mills, are legally required by NBDOE to carry out ambient air quality monitoring as prescribed in their Approvals to Operate. Such Approval conditions also detail the required equipment specifications, locations and reporting frequency. In such cases, the monitoring equipment and maintenance procedures are checked periodically by NBDOE staff or independent auditors, to ensure the required standards for operation and technical accuracy are being met.

In the case of air pollutants which are transported long distances, and which may be found in rural, as well as urban areas, NBDOE establishes and operates its own monitoring sites. The Department also maintains sites in areas where there are multiple large industrial emission sources, such as Greater Saint John. In addition to 13 provincial sites, there is one federally-operated acid rain monitoring site in New Brunswick (at Harcourt, in eastern New Brunswick). Federal support is also provided for the operation of several other monitoring sites in Saint John, Moncton and St. Andrews.

The location of air quality monitoring sites and the main regional and local networks are shown on the following map (Figure 1). More detail on the exact location of each site is provided in the following sections.

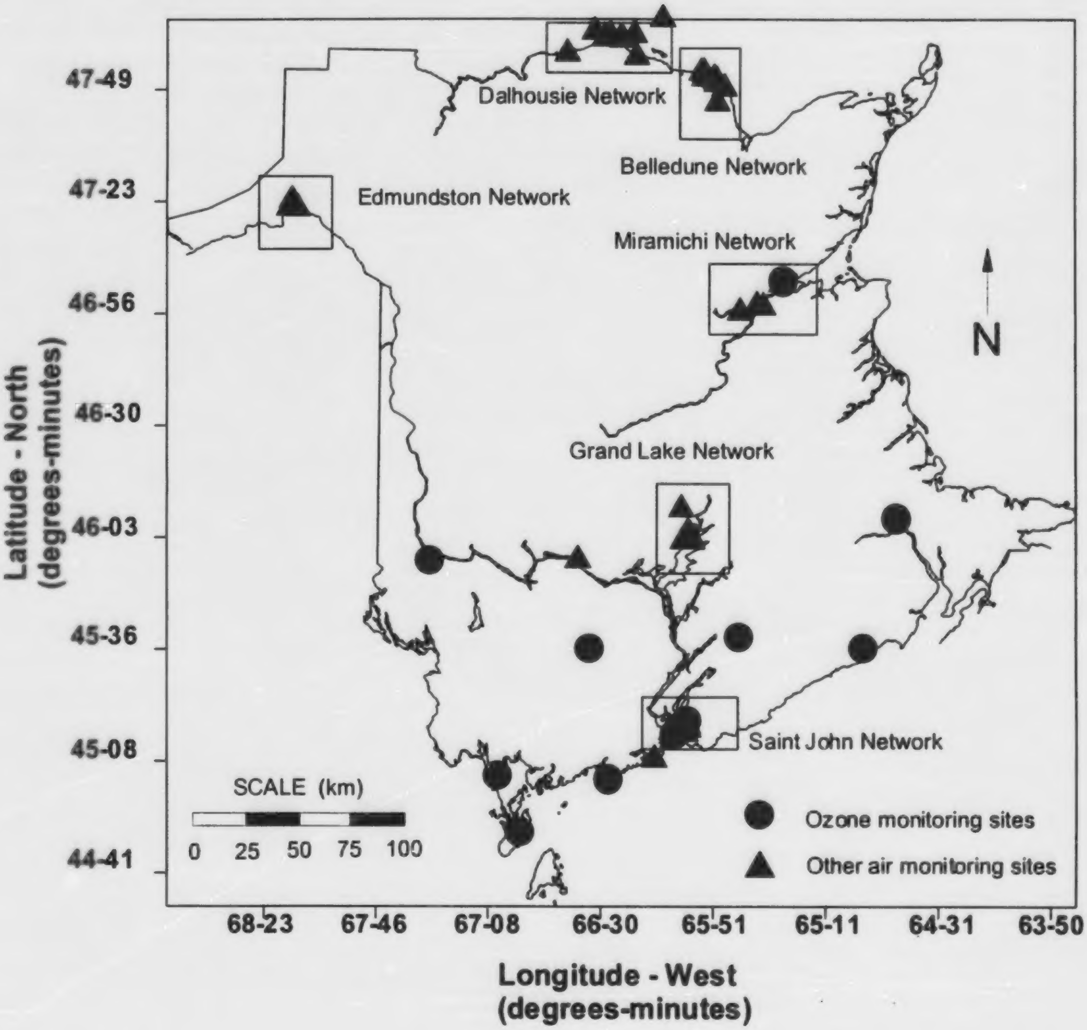

Dalhousie Network
Belledune Network
Edmundston Network
Miramichi Network
N
Grand Lake Network
Saint John Network
SCALE (km)
0 25 50 75 100
Ozone monitoring sites
Other air monitoring sites
47-49
47-23
46-56
46-30
46-03
45-36
45-08
44-41
Latitude - North (degrees-minutes)
68-23
67-46
67-08
66-30
65-51
65-11
64-31
63-50
Longitude - West (degrees-minutes)

Figure 1. Locations of air quality monitoring sites in New Brunswick. The major industry or urban networks are identified. Filled circles on the map indicate rural ozone sites. The remainder indicate ambient monitoring locations for other substances including sulphur dioxide, nitrogen dioxide and particulates.

9. EMISSIONS OF AIR POLLUTANTS

A summary of the principal air pollutants and their source categories is provided in this section. These figures are based upon routine reports supplied to NBDOE by industries, as well as upon estimates calculated from engineering data and published emission factors.

1999 EMISSIONS - NEW BRUNSWICK					
Source Category	Emissions in tonnes per year				
Industrial Sources	Particulate matter	SOx	NOx	CO	VOC
Electric power generation	1 109	84 100	22 417	1 441	221
Other commercial fuel combustion	182	441	104	76	24
Pulp mills	2 139	9 379	2 278	2 262	741
Other wood industry	631	850	203	730	75
Petroleum refining	283	6 124	3 580	907	145
Other chemical industries	323		79	8	
Mining and smelting	174	13 540	175	21	1
Transportation	2 268	3 590	37 111	207 354	22 846
N.B. TOTAL	**7 109**	**118 024**	**65 947**	**212 799**	**24 053**

Notes: SOx = SO_2 plus SO_3; NOx = NO plus NO_2. Transportation figures are estimates for 1995, source: Environment Canada. VOC = volatile organic compound.

The results are divided into two main categories: industrial sources, and transportation. Industrial sources include major installations such as power generating stations, oil refineries, pulp mills and metal smelters. In such situations, air pollution is typically emitted from a small number of chimney stacks at relatively high rates. In contrast, the transportation category includes domestic and heavy-duty vehicles, plus air, marine and rail emissions. In this category, emissions are usually released at lower rates, spread out over a large area.

In addition to these categories, there are also significant emissions from other sources such as construction, domestic fuel use, and emissions from open sources such as forest fires and dust from roads. Note that estimates for these categories are not included in the totals given in the table. Work is ongoing to improve the accuracy of emissions estimates from these sources. Details of this work can be found on the internet at: http://www.ec.gc.ca/pdb/ape/cape_home_e.cfm.

In 1999, industrial emissions of sulphur oxides (SOx) fell by over 10% from 1998. Nitrogen oxide emissions fell by a similar amount. Emissions of particulates were down

12%, and VOCs 7%. Industrial CO emissions increased by about 8%. Note that the industry fraction of total CO emissions is less than 3%, with the bulk being emitted by the transportation sector.

Additional information on air pollutant emissions in New Brunswick may be found in other reports (e.g. Delauriers, 1995; Environment Canada, 1998; Jaques, 1997).

10. AIR QUALITY MONITORING RESULTS FOR 1999

This report contains information for 1999. Results are presented for each monitoring network in the Province. The locations of the monitoring sites are shown on regional scale maps. The numeric results are shown in tables, and further details in chart form appear in Appendix III.

Explanatory notes are provided on each network, and a discussion of the results for each network is included.

A. SAINT JOHN

The Saint John area has the longest history of air quality monitoring in New Brunswick, beginning in 1961 (see boxes on pages 1-2). Since that time, air quality has been monitored at more than 30 different locations in the city and surrounding area. Air quality monitoring sites which are presently active (a total of 12 separate locations) are shown on the following map (Figure 2).

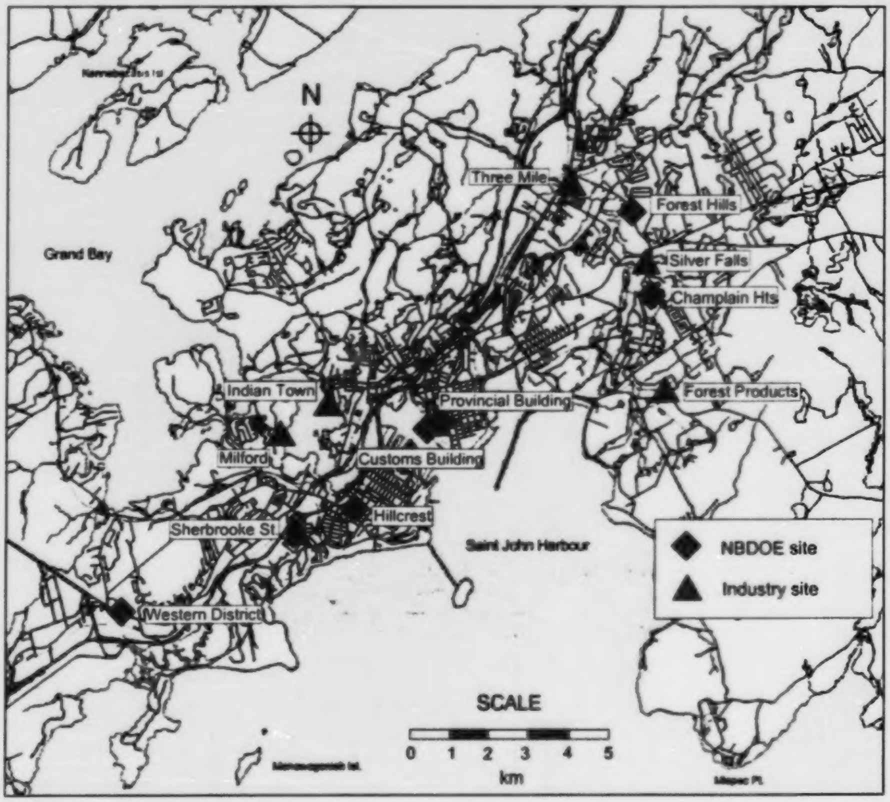

N
Grand Bay
Three Mile
Forest Hills
Silver Falls
Champlain Hts
Indian Town
Provincial Building
Forest Products
Milford
Customs Building
Hillcrest
Sherbrooke St
Saint John Harbour
Western District
NBDOE site
Industry site
SCALE
0 1 2 3 4 5
km

Figure 2. Air quality monitoring sites in Saint John, New Brunswick.

Most of these sites are electronically linked to a central computer at the NBDOE regional office in Saint John. This system communicates with the monitors a minimum of once each hour and obtains the latest readings. These are then added to the existing data archive and are used to prepare IQUA public information messages, as well as to determine the nature of any abatement actions required by industries if concentrations rise above pre-determined trigger points. Such episode control systems are specified in various Approvals to Operate issued to major emission sources by the Department.

On the City's west side, three monitoring sites for hydrogen sulphide are operated by Irving Pulp and Paper Ltd. NBDOE also operates a site at the Hillcrest Baptist Church off Lancaster Avenue, at which sulphur dioxide, hydrogen sulphide and PM_{10} are monitored, and another site on Manawagonish Road, for PM_{10} only. In east Saint John, three sites for sulphur dioxide are operated by Irving Oil Ltd, as required by the company's operating approval, and results are sent electronically to the Department's data system.

NBDOE also maintains sites at Forest Hills and Champlain Heights in the eastern suburbs, and at the Customs and Provincial buildings in the downtown area. The Customs site has monitors for ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide and coefficient of haze (a measure of particulate). At Forest Hills there are monitors for ozone, sulphur dioxide, nitrogen oxides, coefficient of haze, PM_{10}, $PM_{2.5}$ and volatile organic compounds. The Champlain Heights site monitors sulphur dioxide only.

A.1 Carbon Monoxide

This pollutant is monitored at the Customs Building site to provide data representative of the city centre. Peak hourly values in every month were well below the applicable standard of 30 ppm in 1999. There were also no exceedances of the 8-hour standard of 13 ppm.

A.2 Nitrogen Dioxide

There were no exceedances of the 1-hour standard of 210 ppb at either the Forest Hills or Customs Building monitoring sites in 1999. Neither were the 24-hour standard (105 ppb) or the annual standard (52 ppb) exceeded. Nitrogen dioxide levels at the Customs site tended to be somewhat higher than those at Forest Hills, although still well within the applicable standards at all times.

A.3 Sulphur Dioxide

The annual average standard of 11 ppb was slightly exceeded at Forest Hills, which recorded an annual average of 12 ppb in 1999. Some exceedances of the 1-hour and 24-hour standards also occurred during 1999, although the number of exceedances was substantially lower than in any of the previous three years. Results are summarised by site in the following tables.

Exceedances of the 1-hour sulphur dioxide standard in 1999
Saint John (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Forest Hills	0	0	0	0	0	1	0	0	1	0	0	0	2
Champlain Hts	0	0	0	0	0	0	0	0	0	0	0	0	0
Hillcrest	0	0	0	0	0	0	0	0	0	0	0	0	0
Customs	0	0	0	0	0	0	0	0	0	0	0	0	0
Three Mile	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest Products	1	0	0	0	0	0	0	0	0	1	2	0	4
Silver Falls	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	1	0	0	1	1	2	0	6

The 1 hour standard is 17 pphm, which is equivalent to 170 ppb.

Exceedances of the 24-hour sulphur dioxide standard in 1999
Saint John (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Forest Hills	0	0	0	0	0	4	7	14	0	0	0	0	25
Champlain Hts	0	0	0	0	0	0	0	0	0	0	0	0	0
Hillcrest	0	0	0	0	0	0	0	0	0	0	0	0	0
Customs	0	0	0	0	0	0	0	0	0	0	0	0	0
Three Mile	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest Products	0	0	10	0	0	0	0	0	0	1	14	0	25
Silver Falls	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	10	0	0	4	7	14	0	1	14	0	50

The 24-hour standard is 6 pphm, which is equivalent to 60 ppb.

Saint John is an industrial city with several major emission sources close to its centre. In spite of this, and the fact that local sulphur dioxide standards were made twice as stringent as the National Objectives in 1995, compliance was 100% at five of the seven monitored locations during 1999 (up from two in 1998). Although the goal of full compliance has yet to be fully attained in the case of sulphur dioxide in parts of Saint John, the present system of air quality management is considered to be working well.

Tables of Exceedances – What they Mean

The numbers in the tables of exceedances show the number of occasions when readings were above the standard. For example, the one hour standard for sulphur dioxide in Saint John is 170 ppb. Any hourly period when the measured value was higher than 170 ppb counts as one exceedance of that hourly standard. A 31-day month has 31 x 24 = 744 hours, so the maximum possible number of hourly exceedances for the month would be 744. If that happened, compliance would be 0%. Conversely, with no exceedances, compliance would be 100%.

Considering the Forest Products site in November, 1999, 2 individual hours out of 720 were logged exceeding the 170 ppb level. Compliance for the month was 718 out of 720 hours, or 99.72%.

Where 24-hour standards exist (as for SO_2 and H_2S), compliance is calculated using a running 24 hour average. In other words, not just individual 24 hour calendar days are considered, but every possible 24 hour period in each month, e.g. the 24 hours ending at 10 am on the 5th, the 24 hour period ending at 11 on the 5th, and so on for the whole period in question. Each hour, the 24 hour average is recalculated.

Any hour that the calculation is made and the result is over the 24-hour standard, counts as an exceedance. There could be up to 744 exceedances in a 31-day month. Because a 24-hour average tends to rise and fall gradually, compared to an hourly reading, the total number of 24-hour exceedances is almost always greater than the number of 1-hour exceedances.

Compliance with sulphur dioxide standards during 1999 at the remaining two sites, expressed as a percentage of all hours, ranged from 99.95% to 99.98% for the 1-hour standard, and equalled 99.71% for the 24-hour standard.

A.3.1 Sulphur Dioxide Episode Control

An episode control program is in place to prevent ambient sulphur dioxide reaching undesirably high levels in Saint John. Control actions are initiated by major industries in the city in response to measurements made at the fixed monitoring sites.

As noted earlier, these control actions are made mandatory by being incorporated into the relevant Approvals to Operate issued by NBDOE. The episode control plans themselves are subject to continual review. NBDOE meets regularly (at least 6 to 8 times per year) with staff of the major industries in the city to review compliance in respect of sulphur dioxide.

All exceedance events are examined in detail and any shortfalls in the nature and extent of response action are addressed. NBDOE staff sometimes request emission control actions separate from or in addition to those specified in the response plans. Such action may be warranted due to unusual conditions, such as poor dispersion, or during periods when smog advisories are in effect.

Some of the ways in which industries respond to rising levels of sulphur dioxide include switching to lower or near-zero sulphur fuels, and reducing production rates or electricity generating rate. Response action is begun when monitored concentrations reach approximately half the 1-hour standard of 17 parts per hundred million (i.e. at 8 pphm).

A.4 Ground Level Ozone

Ozone was monitored at three sites in the city during 1999: Forest Hills, the Customs Building and in west Saint John at Hillcrest Church. During 1999 there were 18 exceedances of the 1-hour National Ambient Air Quality Objective for ozone of 82 ppb in the Saint John Network, all recorded during an episode in July. As noted earlier, this objective is employed only as a guideline for purposes of evaluation. There are no standards presently in effect for ground level ozone in New Brunswick. Further details follow in section 11, where complete results for all ozone monitoring sites are summarised.

As noted previously, ozone is an air pollutant which can travel long distances, especially when winds carry the ozone over water (an example is transport from the Boston area to New Brunswick over the Gulf of Maine and Bay of Fundy). Years of monitoring, modelling and trajectory analysis have shown that the vast majority of ground level ozone observed in New Brunswick originates in the north-eastern United States.

A.5 Particulate matter

A.5.1 PM_{10} High Volume Sampler

NBDOE operates high volume samplers at four sites in Saint John (Forest Hills, Provincial Building, Hillcrest and Western District Police) which are specially modified to provide data on PM_{10}. As noted earlier, there is no Canadian National Objective presently in place for PM_{10}, and no provincial standard in New Brunswick. For evaluation purposes, reference is made to the standards in place in Greater Vancouver, the United States, and the State of California (page 6).

The California/GVRD 24-hour standard of 50 micrograms per cubic metre was exceeded six times at the Hillcrest site, eight times at the Provincial Building, twice at Forest Hills and four times at the Western District Police site during 1999. Although not large, this is a greater number of exceedances than seen in recent years. The majority of higher values occurred in the fall and winter and appear to have been regional-scale events when weather conditions caused poor dispersion and a resulting build-up of particulate matter. The extensive construction activity occurring in the city may also have had an influence on the results.

A.5.2. PM_{10} (TEOM)

PM_{10} was measured during 1999 at Forest Hills using a continuously recording TEOM instrument. Continuous recording provides complete coverage for all hours in the year, as opposed to the 1 in 6 day schedule used nationally for high volume samples. This technology has now been available for several years and is being adopted around the world.

The 1999 results comprised over 6,300 hours, or more than 72% of the year. Hourly peak values exceeded 100 micrograms per cubic metre on three or four occasions. The majority of hourly readings were below 40 micrograms per cubic metre. Some other jurisdictions have a standard of 50 micrograms per cubic metre for PM_{10}. This value was only exceeded for a total of 5 hours, in October. There was no clear trend for higher values to occur at any particular time of year.

A.5.3 $PM_{2.5}$ (TEOM)

A TEOM device measuring $PM_{2.5}$ was operated at Forest Hills in 1999. There were instrument problems during the summer which reduced the data available to about 60% of the total hours of the year. Peak hourly readings were around 50-60 micrograms per cubic metre. The agreed-upon Canada-Wide Standard for $PM_{2.5}$ is 30 micrograms per cubic metre as a 24-hour average, itself averaged over 3 years (see box). As such it is only possible to determine compliance after a minimum of 3 years of data. In 1999, there were no occasions when the 24-hour average exceeded 30 micrograms per cubic metre. The 98th percentile reading was 18.4 micrograms per cubic metre.

New Canada-Wide Standard for $PM_{2.5}$: Determining Compliance

Determining compliance with the Canada Wide Standard for $PM_{2.5}$ requires a number of calculations. From all the 24-hour averages for the whole year, the value is computed which is greater than 98% of all the readings. In other words, only 2% of the readings exceeded this value during the year. This is the 98th percentile value. A site is considered in compliance if the average of the 98th percentile values over three consecutive years is below 30 micrograms per cubic metre.

A.6 Hydrogen Sulphide

This air pollutant is monitored at the Hillcrest site (NBDOE) as well as three sites operated by Irving Pulp and Paper (Milford, Indian Town and Sherbrooke St.).

There were a number of exceedances at these sites in 1999, as indicated in the following table. As a percentage of total hours, compliance ranged from 99.93% to 100% for the 1-hour standard and 99.70% to 100% for the 24-hour standard.

Exceedances of standards for Hydrogen Sulphide in 1999
Saint John (number of hours)

1-hour standard (11 ppb)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Hillcrest	0	0	0	0	1	0	0	0	0	0	0	0	1
Sherbrooke	0	0	0	0	0	0	0	0	0	0	0	0	0
Milford	0	0	0	0	0	0	0	0	0	0	0	0	0
Indian Town	0	0	0	0	0	4	0	0	0	1	0	1	6
Total	0	0	0	0	1	4	0	0	0	1	0	1	7

24-hour standard (3.5 ppb)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Hillcrest	0	0	0	0	20	0	0	0	0	0	0	0	20
Sherbrooke	0	0	0	0	0	0	0	0	0	0	0	0	0
Milford	0	0	0	0	0	0	0	0	0	0	0		0
Indian Town	0	0	0	0	0	26	0	0	0	0	0	0	26
Total	0	0	0	0	20	26	0	0	0	0	0	0	46

A.7 Volatile Organic Compounds (VOCs)

VOCs have been measured at Forest Hills in east Saint John since 1992. Measurements have also been made for the same period of time at Point Lepreau, approximately 40 km southwest of the city. The Lepreau site is predominantly upwind of Saint John and serves as a control or reference site, representative of rural southern New Brunswick. The monitoring program for VOCs is a collaborative one between NBDOE and Environment Canada. NBDOE staff maintain the monitoring sites and set up the equipment to take samples (normally every 6 days). Environment Canada performs the analyses on the collected air samples.

Each sample is based on air collected over a 24-hour period and is routinely analysed for over 150 compounds. These include VOCs which are involved in the formation of ozone, as well as others which may be of interest for other reasons. For example they may be indicators of various kinds of industrial activity, or they may be potentially of concern in their own right (for example substances which are known to be potentially carcinogenic, such as benzene). Some other VOCs which are measured are found at similar concentrations regionally or even globally (such as several CFC compounds). These substances are of key interest in atmospheric research.

There are no ambient air quality standards for VOCs in Canada. Results can be compared against guidelines published by other agencies, and examined over time to look for trends, as well as differences between sites.

The following table lists results for 1999 for selected VOCs, compared with guidelines recommended by various agencies. This subset of VOCs contains compounds which have traditionally been classified as "air toxics", and which are considered potentially harmful to human health. The first line of the results table also shows the average concentration taking into account all VOCs measured at each site. Examination of the results in the table shows that levels of all these compounds, with the exception of carbon tetrachloride, were higher at Forest Hills than at Point Lepreau. This is as expected, as Forest Hills is in a suburban setting influenced by local industrial and other emissions, whereas Point Lepreau is rural, with fewer local source influences. For the selected VOCs for which guidelines could be referenced, concentrations at both monitoring sites were found to be below these targets at both sites, in most cases by a substantial margin.

The substance with the smallest margin of compliance is benzene, comparing the annual average at Forest Hills (0.28 ppb) with the Swedish guideline (0.4 ppb). The annual guideline for benzene recently published in the United Kingdom (5 ppb) has a compliance target date of 2003, with the long-term target being a guideline of 1 ppb (EPAQS, 1994, HMSO, 2000). Benzene is emitted from motor vehicles and is a component of gasoline. In Saint John, the petroleum refinery and other industries would also contribute to ambient concentrations.

Carbon tetrachloride levels at Point Lepreau and Forest Hills are essentially the same. This is expected because this substance has a long lifetime in the atmosphere and there are few significant local emission sources.

In 1999 at Forest Hills, average VOC concentrations (including all 150 compounds) were higher than those recorded in 1998, and similar to the results obtained in 1997. At Point Lepreau, the 1999 average was slightly lower than 1998, and the lowest (by a small margin over 1993) since recording began in 1992.

Additional analysis of VOC data is included in the section on long-term trends (section 13)

1999 VOC Monitoring Results

VOC	Max 24-h averages (ppb)		24-h Guidelines (ppb)	Annual averages (ppb)		Annual guidelines (ppb)
	Forest Hills	Point Lepreau		Forest Hills	Point Lepreau	
Total VOC	122.7	14.3		35.7	6.3	
1,3 butadiene	0.1	0.03		0.04	0.01	1 (UK)
Benzene	0.69	0.36		0.28	0.12	5 (UK) 0.4 (Sweden)
Toluene	3.54	0.69	63* (WHO)	0.94	0.11	10-100 (Sweden)
Ethylbenzene	0.34	0.13	4464* (WHO)	0.13	0.02	
Xylenes	1.0	0.42	1013 (WHO)	0.35	0.04	
Styrene	0.05	0.08	56* (WHO)	0.02	0.01	
Chloromethane	0.7	0.52		0.38	0.3	
Vinyl chloride	0.43			0.25		
1,1 dichloroethylene	0.02			0.01		
Dichloromethane	0.03		792 (WHO)	0.02		100-250 (Sweden)
1,2 dichloroethane	0.09	0.07	159 (WHO)	0.04	0.03	100-150 (Sweden)
Carbon tetrachloride	0.07	0.15		0.05	0.12	
1,2 dichloropropane	0.03			0.03		
Trichloroethylene	0.04			0.03		100-150 (Sweden)
1,1,2 trichloroethane	0.01					
Ethylene dibromide	0.01			0.007		
Tetrachloroethylene	0.02		34 (WHO)	0.02		100-200 (Sweden)
1,1,2,2 tetrachloroethane	0.05					
Formaldehyde	1.38			0.04		
Acetaldehyde	2.09			0.45		

Notes: The guidelines marked with an asterisk (*) are for a weekly period.
Sources: WHO: 1987, 1994,1996 & 1997; Swedish standards: OECD, 1995. UK standards: HMSO, 2000.

A.8 Index of the Quality of the Air (IQUA)

The IQUA system has been used in Saint John for 20 years to help make air quality monitoring results easier to understand. Results for each pollutant measurement are expressed on a scale from 1-100, and classed as "good" (index 0 to 25), "fair" (26 to 50), "poor" (51 to 100) or "very poor" (over 100). Each of the categories is based on the National Air Quality Objectives listed in Appendix II. For example, "good" air quality indicates that pollutants are in the "desirable" range as defined by the air quality objectives. Values in the "fair" range are above the desirable, but below the acceptable objective. IQUA information is distributed daily via the NBDOE web site: http://www.gov.nb.ca/scripts/environm/air/GetValues.idc

This web page is updated three times per day. IQUA information is also accessible by phone via recorded message (dial 636 4991 in the Saint John area). The recorded message is updated hourly.

For each hour, the IQUA index is computed for each pollutant measured at the site. The value reported is the highest of each of the individual values. For example if two pollutants are in the "good" range and one is in the "poor" range, then the index for the hour would be reported as "poor". In addition, the pollutant responsible for determining the overall index value is usually identified.

The IQUA System

National Air Quality Objective		IQUA Level
Exceeds Maximum Tolerable	VERY POOR	100 or more
Exceeds Maximum Acceptable	POOR	51-100
Exceeds Maximum Desirable	FAIR	26-50
Lower than Maximum Desirable	GOOD	0-25

Summary statistics are given here for the three designated IQUA sites in Saint John: Customs Building (uptown), Forest Hills (east) and Hillcrest (west). The charts show the number of hours logged in each IQUA category. It is apparent that the vast majority of the time, air quality was in the "good" category during 1999 (from 97 to more than 98% of the time). The percentage of hours in the "fair" range varied from less than 2% at Forest Hills to 2.5% at the Hillcrest site in West Saint John, the Downtown Customs location recording 3.1%. The percentage in the "poor" category was even lower, with a maximum frequency of just 0.1% at Hillcrest, West Saint John.

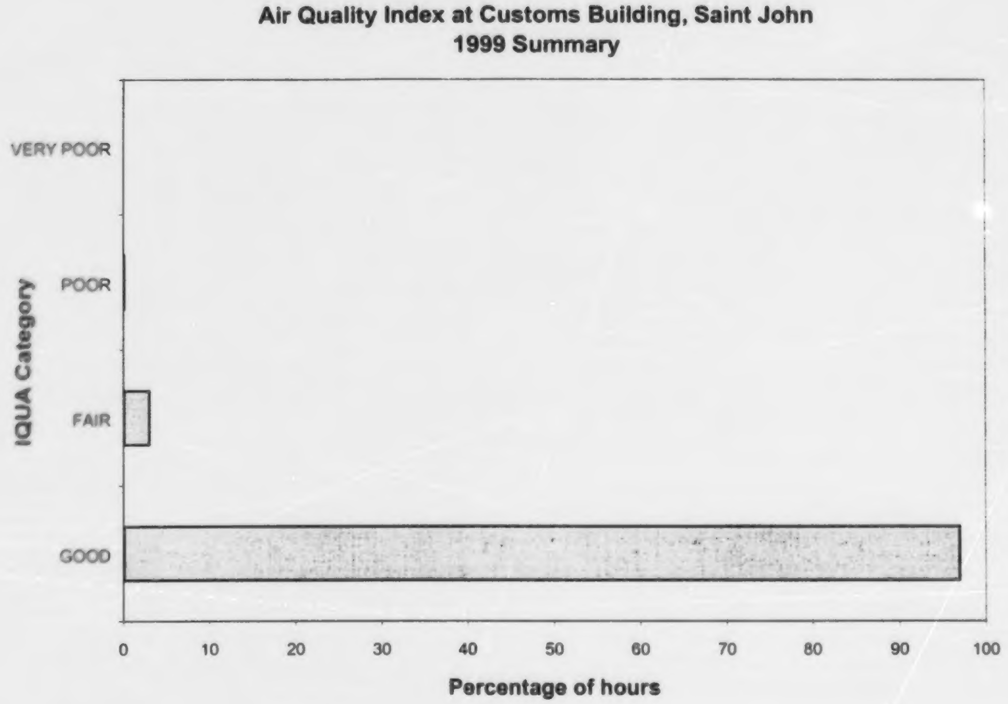


Figure 3. Air quality index summary for 1999: Customs Building, Saint John.

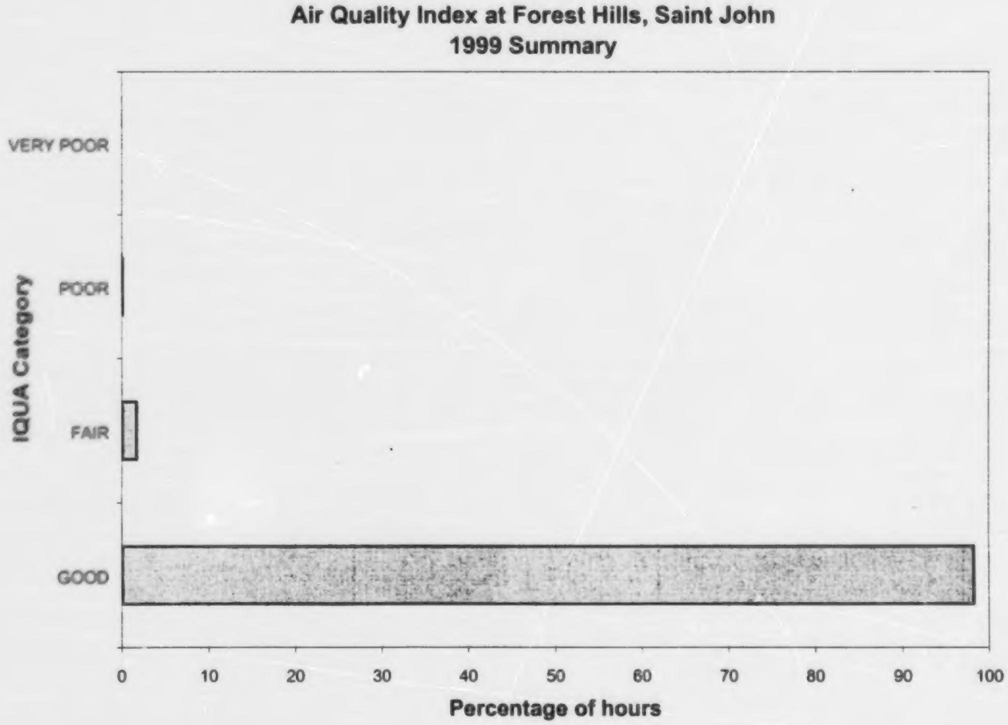


Figure 4. Air Quality Index summary for 1999: Forest Hills, Saint John.

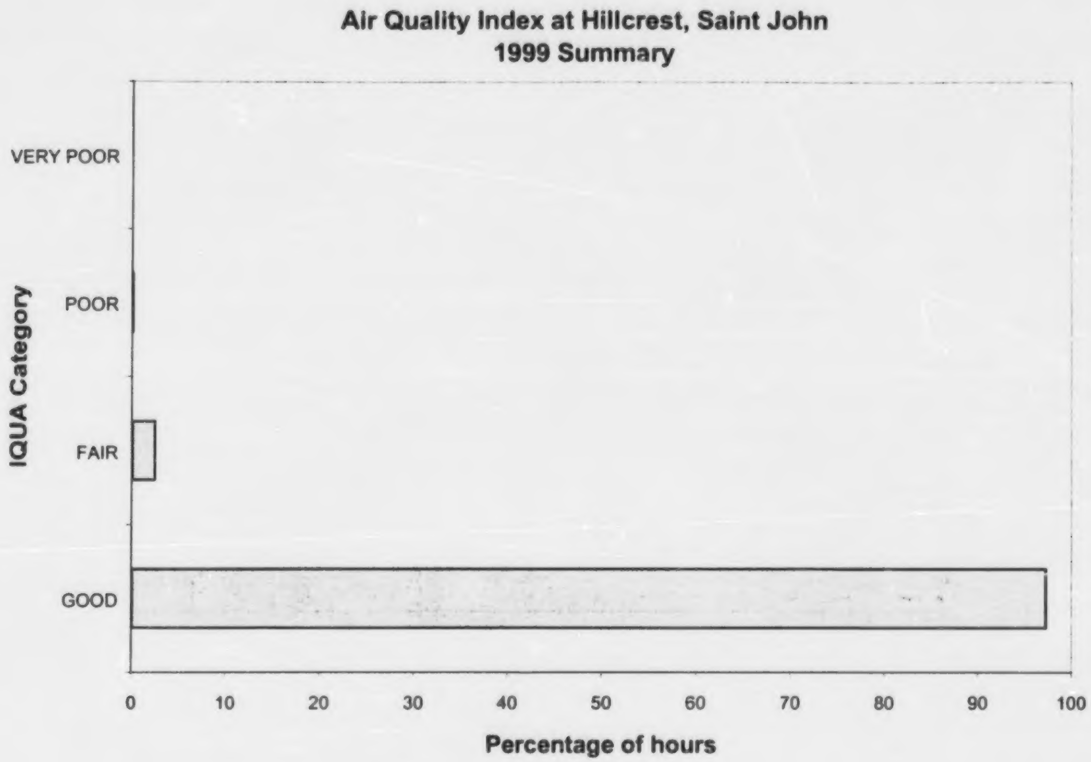


Figure 5. Air Quality Index summary for 1999: Hillcrest, Saint John.

B. MIRAMICHI

There are two monitoring sub-networks in the Miramichi region, one centred on the REPAP pulp mill emission sources, and the other on NB Power's Millbank gas turbine generating site. Pollutants of concern in these networks include hydrogen sulphide and particulates (REPAP) plus nitrogen dioxide and sulphur dioxide (Millbank).

Figure 6 shows the locations of the five sites in the region.

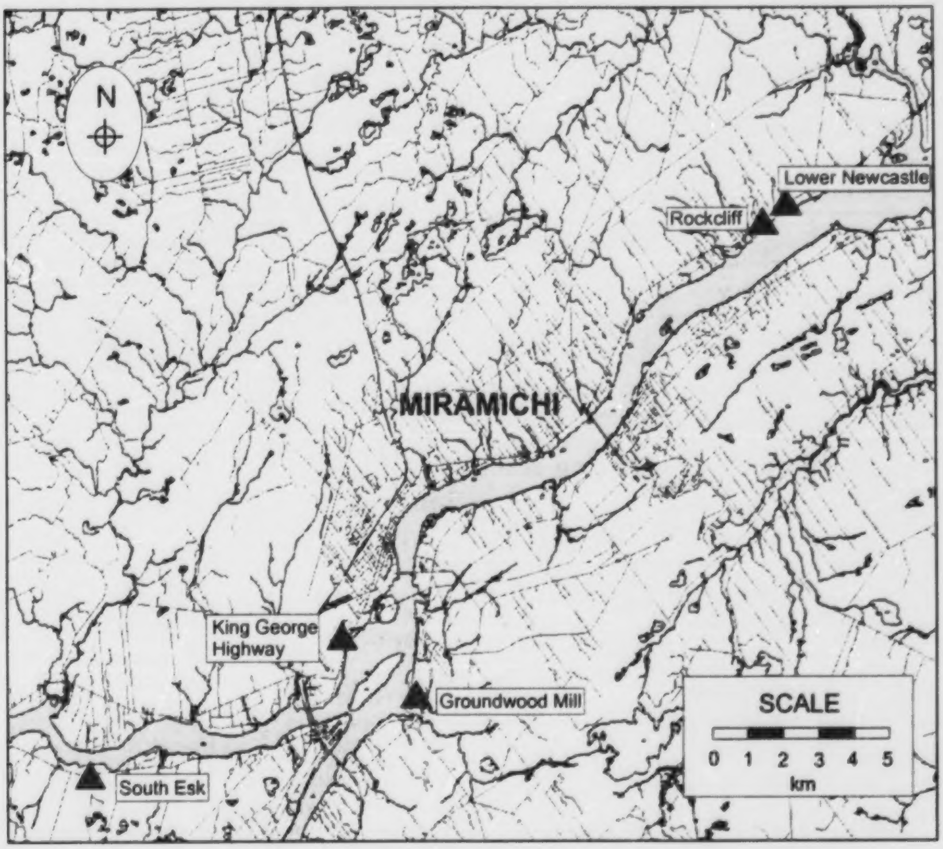

N
Lower Newcastle
Rockcliff
MIRAMICHI
King George Highway
Groundwood Mill
South Esk
SCALE
0 1 2 3 4 5
km

Figure 6. Air quality monitoring sites in the Miramichi Region.

B.1 REPAP NETWORK

B.1.1 Hydrogen Sulphide

Based on measurements for hydrogen sulphide at the Groundwood and King George Highway sites, the compliance summary for 1999 is as follows:

Exceedances of standards for Hydrogen Sulphide in 1999
REPAP sites (number of hours)

1-hour standard (11 ppb)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Groundwood	0	0	0	1	0	1	2	1	0	0	0	0	5
KG Highway	36	0	9	4	36	62	136	79	51	26	38	11	488
Total	36	0	9	5	36	63	138	80	51	26	38	11	493

24-hour standard (3.5 ppb)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Groundwood	0	0	9	0	0	0	0	0	0	0	0	0	9
KG Highway	186	0	69	3	200	362	677	293	272	157	216	62	2497
Total	186	0	78	3	200	362	677	318	272	157	216	62	2506

As in previous years, while compliance at the Groundwood site was good, a significant number of exceedances occurred at the King George Highway site. Compliance was attained for 94.4% of all hours (1-hour standard) and 71.5% of hours (24-hour standard).

Exceedances: why they occur

Exceedances of air quality standards can occur for several reasons. For substances such as hydrogen sulphide, sulphur dioxide, nitrogen oxides, carbon monoxide and TSP, local emissions dominate. Exceedances for these contaminants may be due to emissions which are higher than usual, often together with unusual weather conditions. For example, winds blowing directly from an emission source (such as a smokestack) towards a monitoring site, or conditions when pollutants cannot disperse easily.

In the case of ozone, local emissions are far less important, and exceedances are dependent on weather patterns. Exceedances occur when winds bring ozone into New Brunswick from polluted regions beyond our borders (typically the northeastern US).

Exceedances of TSP often occur due to dust raised by the wind from roads. This often happens in April and May when surfaces dry out and roads and paths are still covered with fine sand from winter applications.

The condensate stripper, installed in 1998 and put into full operation in 1999, did not achieve the desired reduction in TRS emissions and, as a result, a second TRS Reduction Action Plan is being implemented. The Plan includes the collection, treatment and incineration in Power Boiler No.4 of dilute non-condensible gases (DNCG) from five point sources within the mill. Startup of the DNCG system will follow the spring 2001 maintenance shutdown. The Action Plan also includes the conversion of the effluent treatment system inlet settling basins to aerobic operation and the installation of high efficiency burners in lime kiln No.2 for the incineration of the gases stripped off from the condensate stripper. Conversion of the inlet settling basins to aerobic operation is scheduled for completion by year-end 2000. Final engineering and scheduling of the No.2 lime kiln burner is not yet complete (as of November 2000).

B.1.2 Total Suspended Particulate

There were no exceedances of the TSP standard at any of the three monitoring sites during 1999. Detailed results are shown in Appendix III.

B.2 MILLBANK NETWORK

The two sites at Millbank (Rockcliff and Lower Newcastle, see Figure 6) are positioned to assess the impact of NB Power's gas turbine generating station. The pollutants monitored include sulphur dioxide, nitrogen dioxide and TSP.

B.2.1 Nitrogen dioxide

There were no exceedances of the 1-hour or 24-hour standards at either monitoring site in either 1999, and monthly means were all very low. Monthly results for 1999 are shown in Appendix III.

B.2.2 Sulphur dioxide

There was one exceedance of the 1-hour standard at the Rockcliff station, in June 1999. There were no exceedances at the Lower Newcastle site. The 24-hour standard was not exceeded at either location, and the monthly means were also very low. This is both a reflection of the relatively infrequent operation of the Millbank plant, and the low sulphur fuel it uses. Monthly results are shown in Appendix III.

B.2.3 Total Suspended Particulate

None of the measurements made exceeded the 24-hour standard of 120 micrograms per cubic metre in 1999, and almost all were well below this value. All individual results are given in Appendix III.

C. GRAND LAKE - NB POWER

Figure 7 shows the locations of the four monitoring sites in this network. These are sited to monitor the effects of the Grand Lake coal-fired electrical generating station and associated activities. The four monitoring sites are operated by NB Power and each measures sulphur dioxide and TSP.

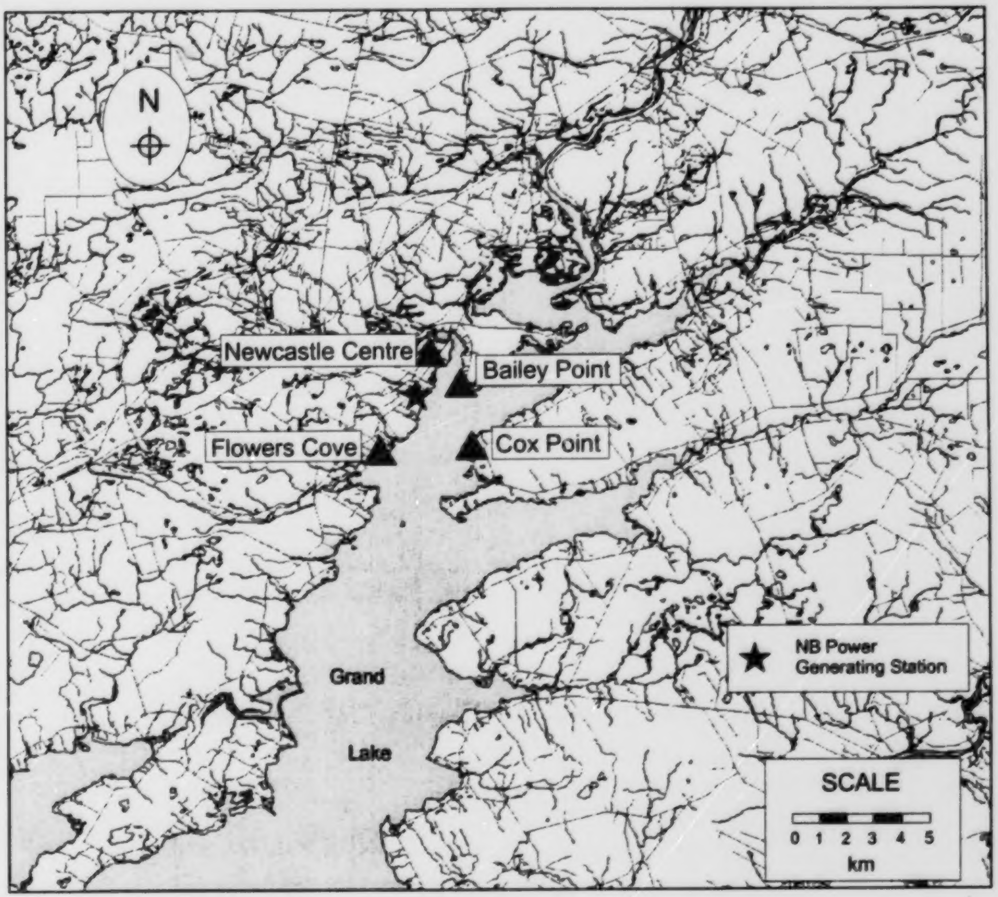

N
Newcastle Centre
Bailey Point
Flowers Cove
Cox Point
Grand
Lake
★ NB Power Generating Station
SCALE
0 1 2 3 4 5
km

Figure 7. Air quality monitoring sites in the Grand Lake Network.

C.1 Sulphur dioxide

Compliance was very good at all sites in 1999. There were no exceedances of the 1-h standard of 34 parts per hundred million or the 24-h standard of 11 pphm.

C.2 Total Suspended Particulate

In 1999, almost all the results were well below the 24-hour standard of 120 micrograms per cubic metre. There was once exceedance at the Flowers Cove site in December. Complete results are given in Appendix III.

D. EDMUNDSTON – FRASER INC.

Figure 8 shows the locations of the two monitoring sites in the region (Cormier and Sacred Heart), located primarily to monitor the impacts of the Fraser Inc. pulp mill. At each site, sulphur dioxide and TSP are monitored.

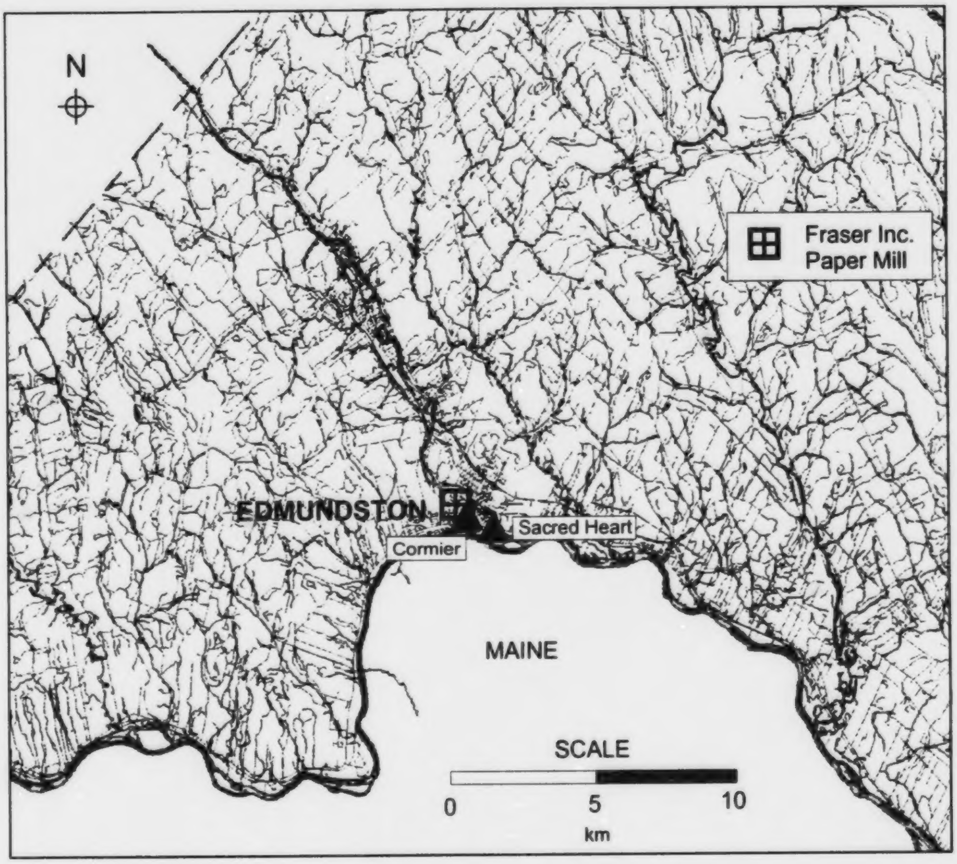

N
Fraser Inc. Paper Mill
EDMUNDSTON
Sacred Heart
Cormier
MAINE
SCALE
0
5
10
km

Figure 8. Air quality monitoring sites in the Edmundston network.

D.1 Sulphur Dioxide

There were two exceedances of the 1-hour standard at the Cormier site, in March and April. There were no exceedances of the 24-h standard at either site during 1999.

D.2 Total Suspended Particulate

There were 9 days on which the 24-hour standard of 120 micrograms per cubic metre was exceeded at the Cormier site, and one exceedance at the Sacred Heart site.

High TSP values generally occur in spring, when pulverised sand from winter road treatment is drying out and is raised by the wind.

Detailed results are shown in Appendix III.

E. BELLEDUNE

There are a number of monitoring sites in the Belledune region. Four of these are located for the assessment of emissions from the Brunswick Mining and Smelting complex. A further five monitors are operated for the assessment of NB Power's coal-fired electrical generating station.

Figure 9 shows the locations of all the monitoring sites in the region.

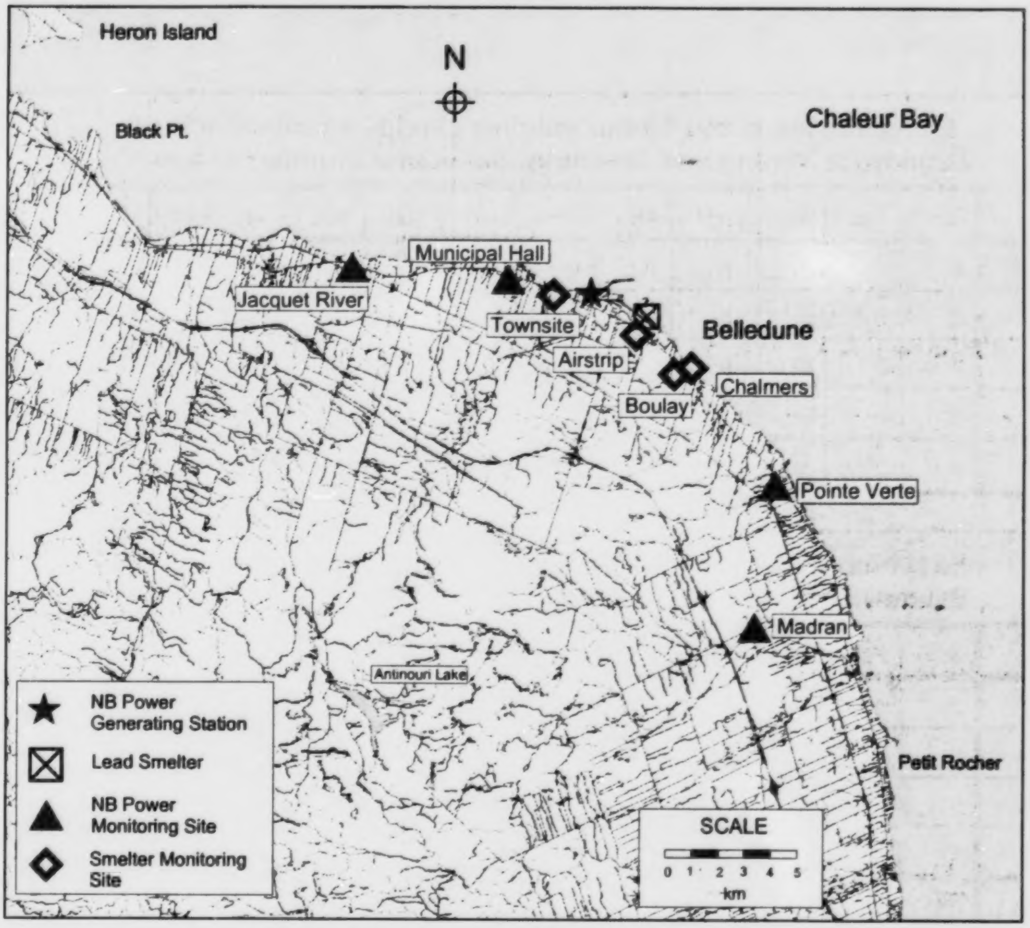

Heron Island
N
Chaleur Bay
Black Pt.
Municipal Hall
Jacquet River
Townsite
Belledune
Airstrip
Chalmers
Boulay
Pointe Verte
Madran
Antinouri Lake
Petit Rocher
NB Power Generating Station
Lead Smelter
NB Power Monitoring Site
Smelter Monitoring Site
SCALE
0 1 2 3 4 5
km

Figure 9. Air quality monitoring sites in the Belledune Network.

E.1. BRUNSWICK MINING AND SMELTING

All sites in the Brunswick Mining and Smelting network monitor sulphur dioxide, and three also measure TSP.

E.1.1 Sulphur dioxide

In 1999 there was a small number of exceedances of the 1-hour standard, as summarised below. The 1 hour standard is 34 pphm or 340 ppb.

There were exceedances of the 24-hour standard (11.5 pphm or 115 ppb) in February and March at one site.

Exceedances of the 1-hour sulphur dioxide standard in 1999
Brunswick Mining and Smelting, Belledune (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Airstrip	0	2	5	0	0	0	0	0	1	0	2	0	10
Chalmers	0	0	0	0	0	1	0	0	0	0	0	0	1
Townsite	0	0	0	0	0	0	1	0	0	0	0	0	1
Boulay	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	0	2	5	0	0	1	1	1	1	0	2	0	13

Exceedances of the 24-hour sulphur dioxide standard in 1999
Brunswick Mining and Smelting, Belledune (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Airstrip	0	8	21	0	0	0	0	0	0	0	0	0	29
Chalmers	0	0	0	0	0	0	0	0	0	0	0	0	0
Townsite	0	0	0	0	0	0	0	0	0	0	0	0	0
Boulay	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	8	21	0	0	0	0	0	0	0	0	0	29

E.1.2 Total Suspended Particulate

There was one exceedance of the 24-hour standard at the Airfield site. No exceedances occurred at the other two sites. Complete results are summarized in Appendix III.

E.2 NB POWER

There are five sites in this network, all of which monitor for sulphur dioxide. Two sites also monitor nitrogen dioxide.

E.2.1 Sulphur dioxide

Compliance was very good in this network. There was only one exceedance, as summarised below.

Exceedances of the 1-hour sulphur dioxide standard in 1999
NB Power Network, Belledune (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Madran	0	0	0	0	0	0	0	0	0	0	0	0	0
Pointe Verte	0	0	0	0	0	0	0	0	0	0	0	0	0
Belledune E	0	0	0	0	0	1	0	0	0	0	0	0	1
Jacquet River	0	0	0	0	0	0	0	0	0	0	0	0	0
Municipal Hall	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	1	0	0	0	0	0	0	1

The 1 hour standard is 34 pphm or 340 ppb.

In 1999 there were no exceedances of the 24-hour standard of 11 pphm at any site.

E.2.2 Nitrogen dioxide

This contaminant is measured at Belledune East and Municipal Hall. There were no exceedances of the applicable 1 or 24-hour standards in 1999 at either location.

F. DALHOUSIE - NB POWER

Figure 10 shows the locations of the sites in the region. The sites in this region are operated to monitor the effects of the NB Power Dalhousie electrical generating station. Eight sites measure sulphur dioxide; one of the eight also monitors for TSP, and there is one additional TSP site (9 sites in all). Because of potential pollution transport across the Bay of Chaleur, three of the eight stations are located in the province of Québec.

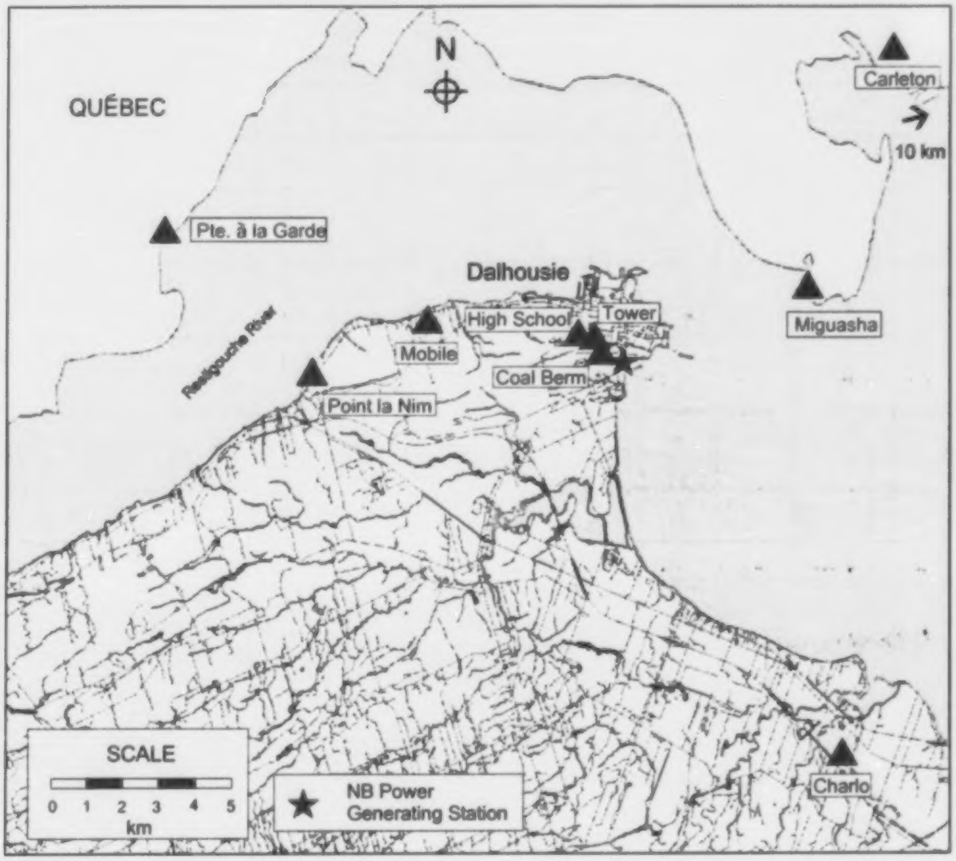

QUÉBEC
N
Carleton
10 km
Pte. à la Garde
Dalhousie
Restigouche River
High School
Tower
Miguasha
Mobile
Coal Berm
Point la Nim
Charlo
SCALE
0 1 2 3 4 5
km
NB Power Generating Station

Figure 10. Air quality monitoring sites in the Dalhousie Network.

F.1 Sulphur dioxide

Compliance with the applicable 1-hour and 24-hour standards was 100% at all sites in 1999, as it was in 1998. Concentrations were notably low; the peak 1-hour reading in the network was 161 ppb, which is less than half the standard. Monthly average concentrations were also very low as can be seen in Appendix III.

F.2 Total Suspended Particulate

TSP was measured at the Coal Berm and Dalhousie Tower sites. Results are shown in Appendix III. None of the individual readings obtained were above the 24-hour standard of 120 micrograms per cubic metre in 1999, and the annual geometric means were also well below the standard of 70 micrograms per cubic metre.

G. ATHOLVILLE - AV CELL INC

G.1 Sulphur dioxide

AV Cell Inc operates a pulp mill in Atholville, and maintains two associated ambient air monitoring sites, Boom Road (to the west of the mill) and Dairy Queen (east). Sulphur dioxide is measured at both sites. Compliance during 1999 was good, with three exceedances of the 1-hour standard (340 ppb) at the Dairy Queen site and no exceedances at the Boom Road site. The 24-h standard (113 ppb) was not exceeded at either site.

H. FREDERICTON

A multi-parameter air quality monitoring site was established in Fredericton in April, 1999. The site is on Aberdeen Street, in an area representative of the "downtown" residential and business district. The site is also considered representative of a wider area for pollutants such as ozone, which are regional in nature.

H.1 Carbon monoxide

No exceedances of the 1-hour or 8-hour standards (respectively 30 ppm and 13 ppm) were recorded. Values were higher in the fall and winter months than during the summer, but even then, peak hourly readings were less than 10% of the standard.

H.2 Nitrogen dioxide

No exceedances of the 1 or 24-hour standards (210 ppb and 105 ppb) were recorded. As for carbon monoxide, higher readings were seen in the cooler months, but levels remained low. The highest hourly readings were less than 15% of the standard.

H.3 Ground level ozone

There were two hours recorded which exceeded the national 1-hour objective for ozone, both in June. Overall during 1999, ozone levels were moderate to low across New Brunswick, when compared with previous years. There is additional discussion of data from the ozone network in section 11.

H.4 Total suspended particulate

The monitoring site for TSP is at the fire hall on the corner of York and Dundonald streets. There were four readings in 1999 which exceeded the 24-hour standard of 120 micrograms per cubic metre. Three of these readings were over 200 micrograms per cubic metre. These high values are thought to be due to construction activity at the adjacent York/Dundonald intersection.

H.5 $PM_{2.5}$ Particulate matter

Fine particulate matter ($PM_{2.5}$) is measured at the Aberdeen St site using a TEOM instrument, which provides a continuous record of particulate concentrations. This unit was installed in June, 1999. Data obtained for the remainder of the year indicated generally moderate to low particulate concentrations. Air quality standards for $PM_{2.5}$ are in the process of being adopted in Canada (see discussion of Canada-Wide standards on page 4. The proposed standard is a 24-hour average of 30 micrograms per cubic metre. This value was exceeded in one episode in August 1999 for a total of 19 hours. Compliance with the new Canada-Wide Standard will be based on data averaged over three years, so it is not yet possible to say whether Fredericton will exceed this standard. Compliance will also be based on the 98th percentile value of the 24-hourly concentrations, calculated for each year. This means the value which is only exceeded by 2% of the readings in the time period being looked at. This 98th percentile value was 22.7 micrograms per cubic metre in 1999. If 1999 turns out to be typical, the city would expect to be in compliance the majority of the time.

H.6. Index of the Quality of the Air

The establishment of a multi-parameter monitoring site in Fredericton in 1999 enabled IQUA statistics to be calculated for the city for the first time. Results are available hourly via recorded voice message at 451 6000.

Results for 1999 are summarised in chart form in Figure 11. This shows that air quality in 1999 in Fredericton was in the good category more than 95% of the time. Ozone was responsible for the majority of the approximately 5% of hours classified in the fair category.

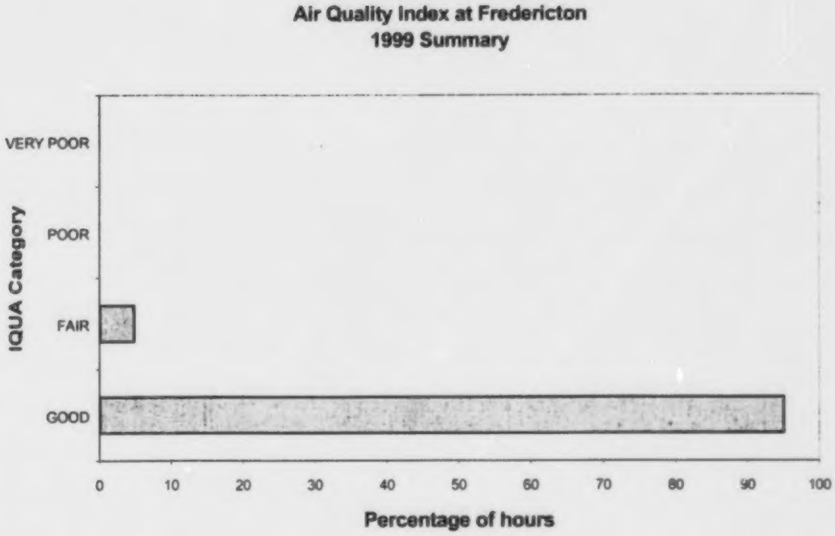


Figure 11. Air quality index summary for 1999 at Fredericton.

I. NACKAWIC

The St. Anne-Nackawic Pulp Company Ltd established an ambient air monitoring site during 1999, as required by the Air Quality Approval issued by the NBDOE. The site began collecting data in June. Sulphur dioxide, total reduced sulphur (TRS) and total suspended particulate (TSP) are measured, as well as wind speed and direction.

Compliance was 100% for sulphur dioxide for the period June-December. For TRS, there were four exceedances of the 1-h standard of 11 ppb (in July, October and December), as well as 33 exceedances of the 24-h standard (all in December). The results for TSP showed low concentrations and no exceedances were recorded.

J. MONCTON

The Moncton air quality monitoring site is situated at the Highfield Street water pumping station. The site location was chosen to provide readings representative of the central city suburbs, in areas which may be influenced by emissions from vehicles or institutional heating systems, as well as regional pollutants such as ozone.

J.1 Carbon monoxide

No exceedances of hourly or 8-hourly standards for carbon monoxide occurred during 1999. Readings were similar to those recorded in downtown Saint John, and although slightly higher than those in Fredericton, were still well below standards.

J.2. Nitrogen dioxide

No exceedances of hourly or 24-hourly standards for nitrogen dioxide occurred from January to July. For the remainder of the year no data were recorded, due to instrument malfunction.

J.3 Ozone

There were three exceedances of the hourly objective for ozone in June 1999. More discussion of ozone data may be found in section 11.

J.4 Index of the Quality of the Air

Hourly IQUA reports are generated for the Moncton site and made available via recorded message at 851 6610. Summary statistics for the period of operation of this site during 1999 are shown in the following figure. As in 1998, the results show that the Moncton data were in the good category more than 98% of the time.

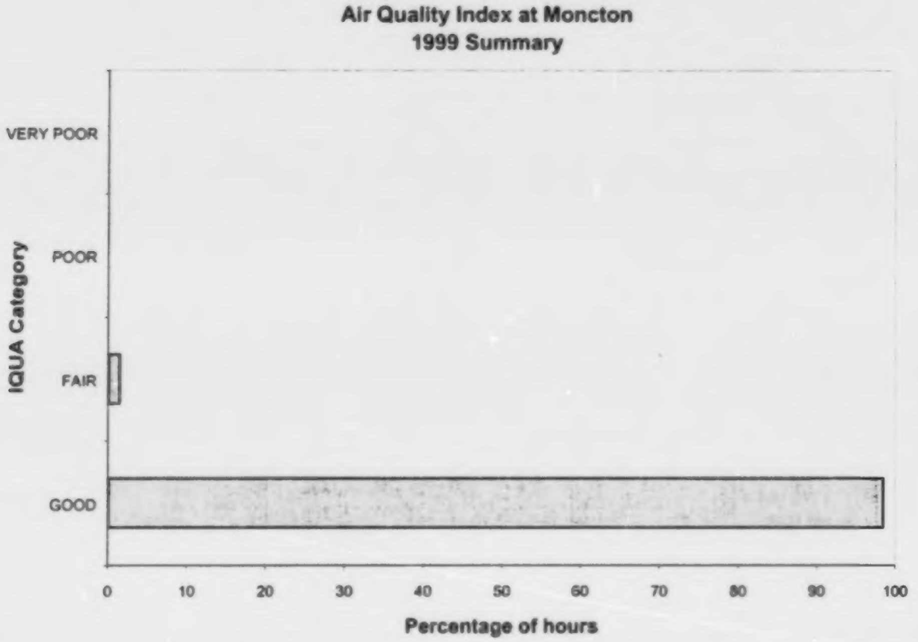


Figure 12. Air Quality Index Summary 1999: Moncton.

K. ST. ANDREWS

The St. Andrews monitoring station is located on the grounds of the Huntsman Marine Science Centre and is operated with the support of staff from the Centre and NBDOE. This site has been used for a variety of special sampling projects and is especially suitable for investigating trans-boundary air pollution. Currently, projects operated at St Andrews by the province include ozone and $PM_{2.5}$ monitoring. Additionally, mercury concentrations in the air, and mercury in precipitation are also monitored at this site, funded and overseen by Environment Canada. This is the only location in the province where these kind of mercury measurements are made, and one of only two in the Maritimes.

K.1 $PM_{2.5}$ (TEOM)

The St Andrews TEOM unit collected valid data for over 80% of the year during 1999. In general, readings were very low at this site, hourly values seldom exceeded 20 micrograms per cubic metre, with the majority below 10 micrograms per cubic metre. In mid-July there was a notable haze episode which was tracked up the entire eastern seaboard from Cape Cod northwards. This event was clearly picked up at St Andrews and resulted in a total of 28 hours over 30 micrograms per cubic metre (24-h average). This was the only event during the year when the proposed Canada-Wide Standard was exceeded. The 98th percentile value for the year (based on 24-hour averages) was 13.7 micrograms per cubic metre.

K.2 Mercury monitoring

Mercury is of concern as an environmental contaminant because of its ability to accumulate in living organisms, potentially reaching concentrations which could pose a hazard to health in humans and wildlife (e.g. NESCAUM, 1998). Although mercury has been recognised as an environmental pollutant for decades, relatively little monitoring and assessment of the transport and behaviour of mercury in the atmosphere has taken place. Most attention has been paid to direct discharges, for example of industrial, water-borne effluents. Recently, the New England Governors and Eastern Canadian Premiers identified mercury as a substance of concern in the east of Canada and the United States, and developed an Action Plan to improve our understanding of its impacts, as well as proposing measures to reduce man-made emissions (NEGECP, 1998).

The mercury monitoring conducted at St Andrews contributes to the scientific understanding of mercury in the environment. The results are used in research (for example into atmospheric processes) as well as in wildlife and other studies.

The following table summarises results of the mercury monitoring program so far. These monitoring studies are operated cooperatively between Environment Canada, the Huntsman Marine Science Centre, and NBDOE.

Mercury Monitoring Results 1995-1999			
Ambient Air			
St Andrews		Other sites	
Year	Annual Average (ng/cubic metre)	Site	Annual averages (ng/cubic metre)
1995	1.9	Mt Mansfield, VT	2.0 (94-96)*
1996	1.5	Kejimkujik, NS	1.5 (1996)*
1997	1.4	Westfield, NY	2.6 (94-96)*
1998	1.4	Moss Lake, NY	2.4 (94-96)*
1999	1.6		
Precipitation (rain and snow)			
Year	Mean mercury concentration (ng/L)	Kejimkujik, N.S.	Mean mercury concentration (ng/L)
1996	7.5**	1996	7.4**
1997	6.7**	1997	5.9**
1998	5.8**	1998	5.2**
1999	6.5**	1999	5.0**
Notes: ng = nanograms. 1 nanogram is one thousand-millionth of a gram. Ambient air mercury data supplied by Environment Canada.		References: * NESCAUM (1998) ** NADP (2000)	

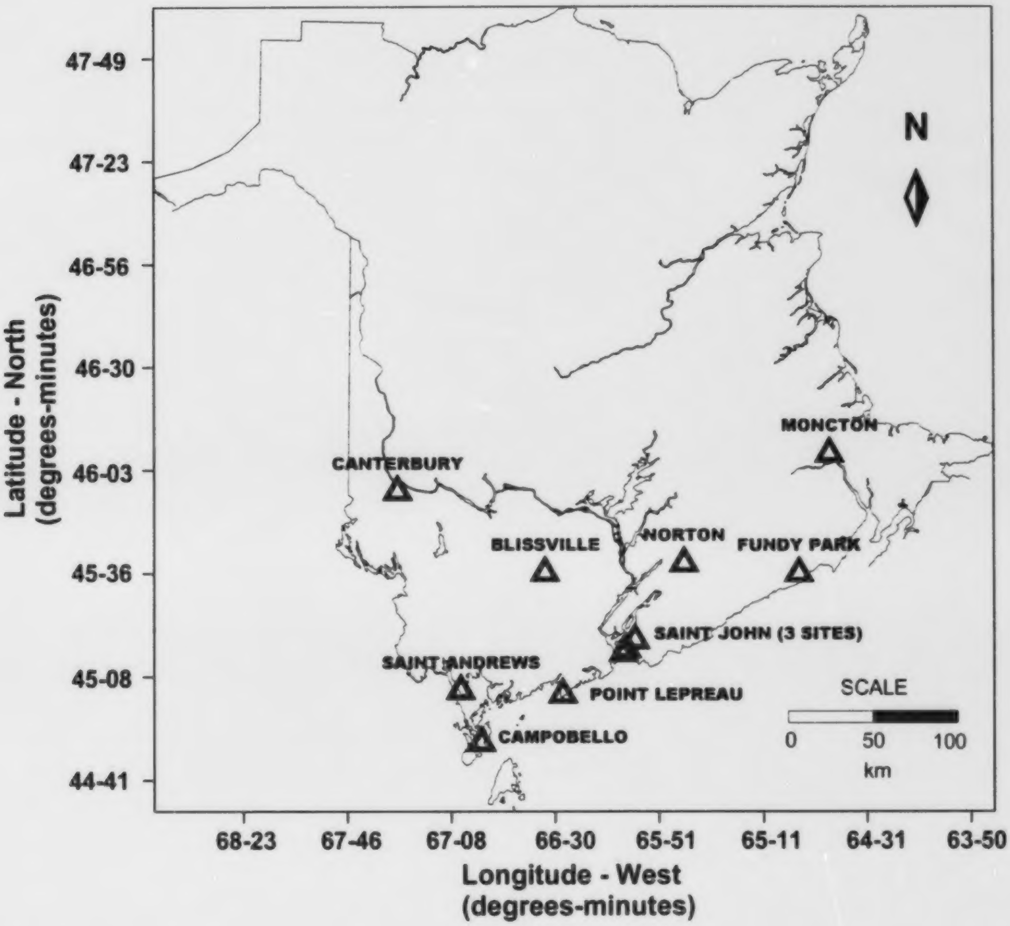
There are no environmental guidelines or objectives for mercury in air or precipitation at present. The data may be used to look for patterns or trends over time, and to compare regionally with other locations. They are also used as input to ecological models which attempt to track how mercury moves though different components of the environment.

The results show several things. In ambient air, the concentration of mercury in vapour form varied between approximately 1.5 and 2 nanograms per cubic metre as an annual average. These values are similar to those measured in Nova Scotia and rural southern Quebec, and lower than readings obtained at sites in parts of New England or southern Ontario, which typically range from 2 to 3 nanograms per cubic metre (NESCAUM, 1998). Over the course of a year, readings at St. Andrews tend to be highest in late winter and lowest in late summer. The reasons for this have not yet been fully explored, but the changing use of fossil fuels through the year is thought to be a major influence (NESCAUM, 1998).

Considering mercury measurements in precipitation, the trends seen at St. Andrews and at Kejimkujik in southwestern Nova Scotia, are similar. Mercury concentrations have generally fallen at both sites since 1996. However at St Andrews, there was an increase from 1998 to 1999, and results from St. Andrews are consistently higher than those from the Nova Scotia location. A detailed examination of results shows that the two sites occasionally exhibit significant differences in mercury concentrations for the same precipitation episodes.

11. RURAL OZONE NETWORK - SOUTHERN NEW BRUNSWICK

Figure 13 shows the locations of the sites which monitor ground level ozone in southern New Brunswick. This network is operated to assess the impact of long-range transported ozone. It focuses on the southern portion of the province, which is the region most affected by long range transport, as shown by special short-term monitoring studies and trajectory analyses (e.g. Fuentes and Dann, 1994; Tordon et al., 1994; Multistakeholder NOx/VOC Science Program, 1997a, 1997b).



N
47-49
47-23
46-56
46-30
46-03
45-36
45-08
44-41
Latitude - North (degrees-minutes)
MONCTON
CANTERBURY
BLISSVILLE
NORTON
FUNDY PARK
SAINT JOHN (3 SITES)
SAINT ANDREWS
POINT LEPREAU
CAMPOBELLO
SCALE
0
50
100
km
68-23
67-46
67-08
66-30
65-51
65-11
64-31
63-50
Longitude - West (degrees-minutes)

Figure 13. Locations of ozone monitoring sites in New Brunswick (1999).

In 1999, exceedances of the one-hour national objective of 82 ppb occurred at eleven out of 12 different sites, but as in 1998, the total number of exceedances was small. There were several significant ozone episodes in 1999, occurring in the months of May, June and July. The exceedance summary is given in the following table. The 1999 results were typical of what has been seen in the past five years or so. The number of hours of exceedance is quite variable from year to year, being heavily influenced by the weather.

Exceedances of the 1-hour ozone objective, 1999
(number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Customs	0	0	0	0	0	0	5	0	0	0	0	0	5
Forest Hills	0	0	0	0	0	0	4	0	0	0	0	0	4
Hillcrest	0	0	0	0	0	0	9	0	0	0	0	0	9
Canterbury	0	0	0	0	0	1	0	0	0	0	0	0	1
Pt. Lepreau	0	0	0	0	0	0	5	0	0	0	0	0	5
St. Andrews	0	0	0	0	0	0	0	0	0	0	0	0	0
Campobello Isl.	-	-	-	0	0	0	2	0	0	-	-	-	2
Fundy Park	0	0	0	0	4	2	0	0	0	0	0	0	6
Norton	0	0	0	0	4	2	0	0	0	0	0	0	6
Moncton	0	0	0	0	3	0	0	0	0	0	0	0	3
Fredericton	-	-	-	-	0	2	0	0	0	0	0	0	2
Blissville	0	0	0	0	1	2	0	0	0	0	0	0	3
Total	0	0	0	0	12	9	25	0	0	0	0	0	46

The 1 hour National Objective is 82 ppb. The Campobello site is operated in summer only.

The frequency of ozone episodes (periods of one or more days with high readings) in New Brunswick is dependent on summer weather conditions. Ozone events typically occur when weather systems result in transport of air into the province from the south-west. A greater than normal frequency of west to north-westerly winds results in fewer days with high ozone.

Monthly means and extremes are shown in Appendix III. There is a natural seasonal cycle in ozone levels, with higher values being seen in the spring months. This is due to seasonal patterns in atmospheric circulation. This feature is apparent at most New Brunswick sites. Monthly mean values can be seen to peak in March and April.

12. ACID PRECIPITATION NETWORK

New Brunswick has operated an extensive precipitation chemistry network since the early 1980's. Since 1987, this has been a partnership effort, with logistical and financial support from NB Power. All samples are analysed at the NBDOE laboratory, and DOE staff co-ordinate the monitoring program, perform data quality assurance, and maintain the official data archive.

The potentially adverse impacts of acid precipitation have been recognised for more than 20 years. Acid rain effects are felt regionally, not just close to the sources of contaminants themselves. The emissions which cause acid precipitation (primarily sulphur dioxide and nitrogen oxides) typically travel long distances - hundreds or even thousands of kilometres - before returning to the surface in rain or snow. The same emissions also contribute to regional haze and fine particulate pollution.

Precipitation chemistry in New Brunswick is affected by the emissions from several large industrial regions which lie upwind, including the American midwest, southern Ontario and Québec, and the Washington-Boston region.

Partly because the site of impact is remote from the point of emission, no standards have been put in place for acid precipitation. Instead, the issue has been managed by the adoption of 'target' or 'critical' loads. These are similar to the objectives used in the management of other air pollutants. Although they are not legally enforceable, they do provide a goal towards which affected US States and Canadian Provinces are working, as emissions are reduced over time.

The severity of acid rain impact is generally measured by computing how much sulphate (a measure of sulphuric acid) falls on each hectare over one year. The target load for acid rain is expressed in terms of this amount of sulphate. In the late 1980's, the proposed target load for eastern Canada was 20 kilograms per hectare per year (kg/ha/yr).

This target was initially designed to provide protection to areas which are moderately sensitive to acidification. This sensitivity varies in different areas, because geological characteristics such as soils and bedrock have different abilities to neutralise the acid precipitation. This is often referred to as the 'buffering capacity'.

Over time, scientists realised that these initial target loads were not adequate to provide long term protection, or protect more sensitive watersheds. The newer concept of critical loads was introduced in the 1990's. Critical loads take into account the nature of individual watersheds, and are calculated to ensure long term protection from acidification.

Critical loads for acidification in New Brunswick range from less than 8 up to 11 kg/ha/year of sulphate input (referred to as acid sulphate deposition). The lowest values of less than 8 kg/ha/yr refer to the most sensitive areas on granite bedrock (e.g. areas of southwestern and central northern New Brunswick), and 11 kg/ha/yr to most of the rest of the Province.

In recent years, acidic deposition has been declining slowly. This means that, for the first time since monitoring began in 1980, the critical load values are beginning to be met over some parts of the Province, although still exceeded in others, notably the sensitive regions in the south west. There is, however, still more effort required to reduce acid deposition further and ensure that the more sensitive lakes and rivers, such as those in southwestern N.B., are provided with long term protection from acid damage. Further cuts in sulphur dioxide emissions are being pursued, both in the Province and those regions of eastern Canada and the United States which are the main source regions of these acid-causing emissions.

Figure 14 shows the location of monitoring sites, and Figure 15 the acid deposition recorded in 1999. Acid deposition decreased significantly across the province in 1999 in comparison with 1998, showing a drop of more than 20%. Deposition averaged across all sites in 1999 was the lowest overall since 1995. Acid deposition, the total amount of a chemical substance entering the environment, is a factor of both concentration in the precipitation and the amount of precipitation received. As a result, there will always be significant variability in acid deposition between years due to variability in weather patterns. Results presented in the following section on long terms trends indicate that when averaged across the province, the concentration of acidic pollutants in precipitation (which is less dependent of the amount of precipitation received) appears to be falling. This trend was reinforced when the 1999 data were added to the trend line. Although encouraging, the data also show that the acid rain issue remains important in New Brunswick, as critical loads for acid rain are still being exceeded, especially in the south.

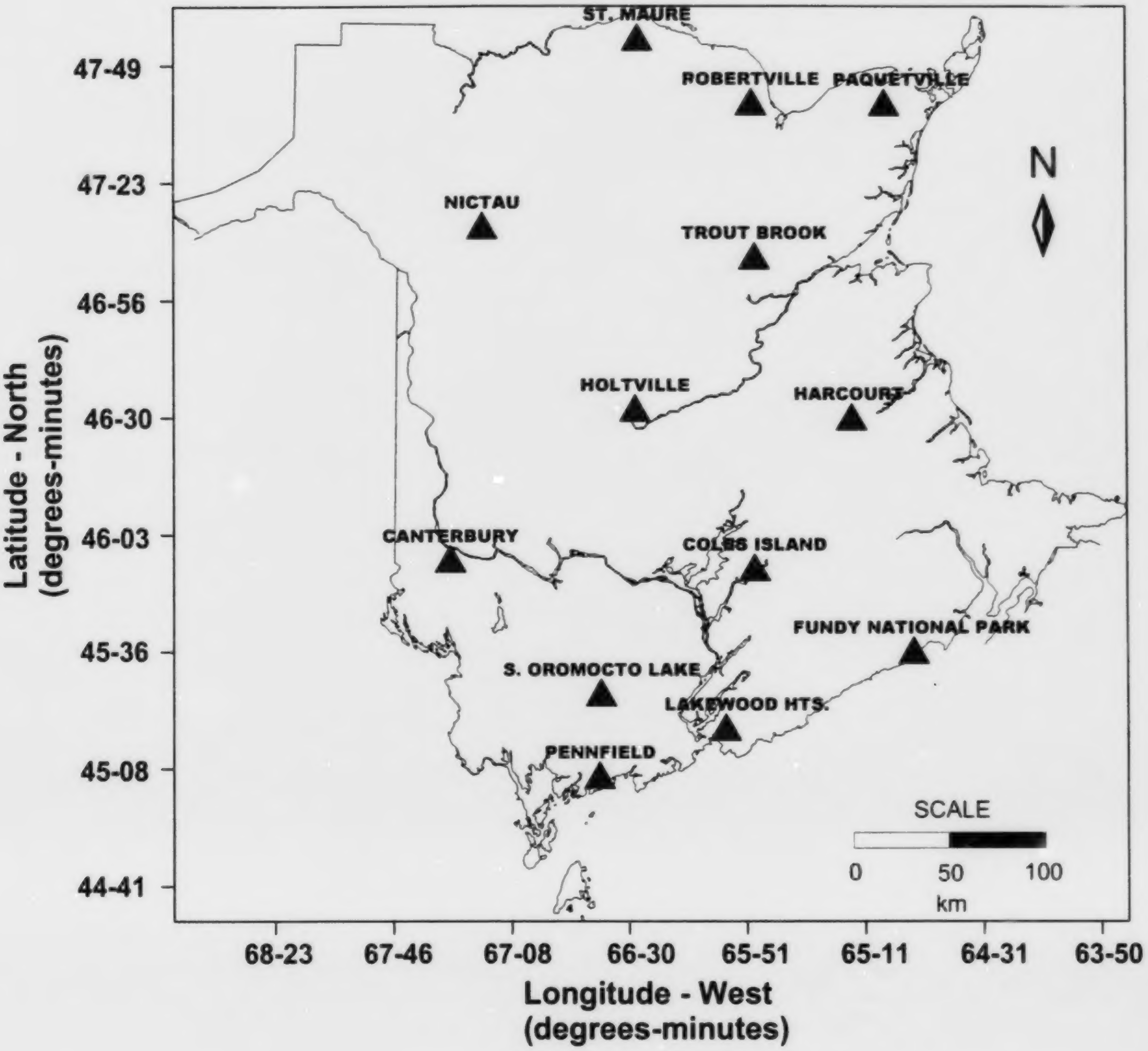

ST. MAURE
ROBERTVILLE
PAQUETVILLE
NICTAU
TROUT BROOK
N
HOLTVILLE
HARCOURT
CANTERBURY
COLES ISLAND
FUNDY NATIONAL PARK
S. OROMOCTO LAKE
LAKEWOOD HTS.
PENNFIELD
SCALE
0
50
100
km
47-49
47-23
46-56
46-30
46-03
45-36
45-08
44-41
Latitude - North
(degrees-minutes)
68-23
67-46
67-08
66-30
65-51
65-11
64-31
63-50
Longitude - West
(degrees-minutes)

Figure 14. Location of acid rain monitoring sites in New Brunswick (1999).

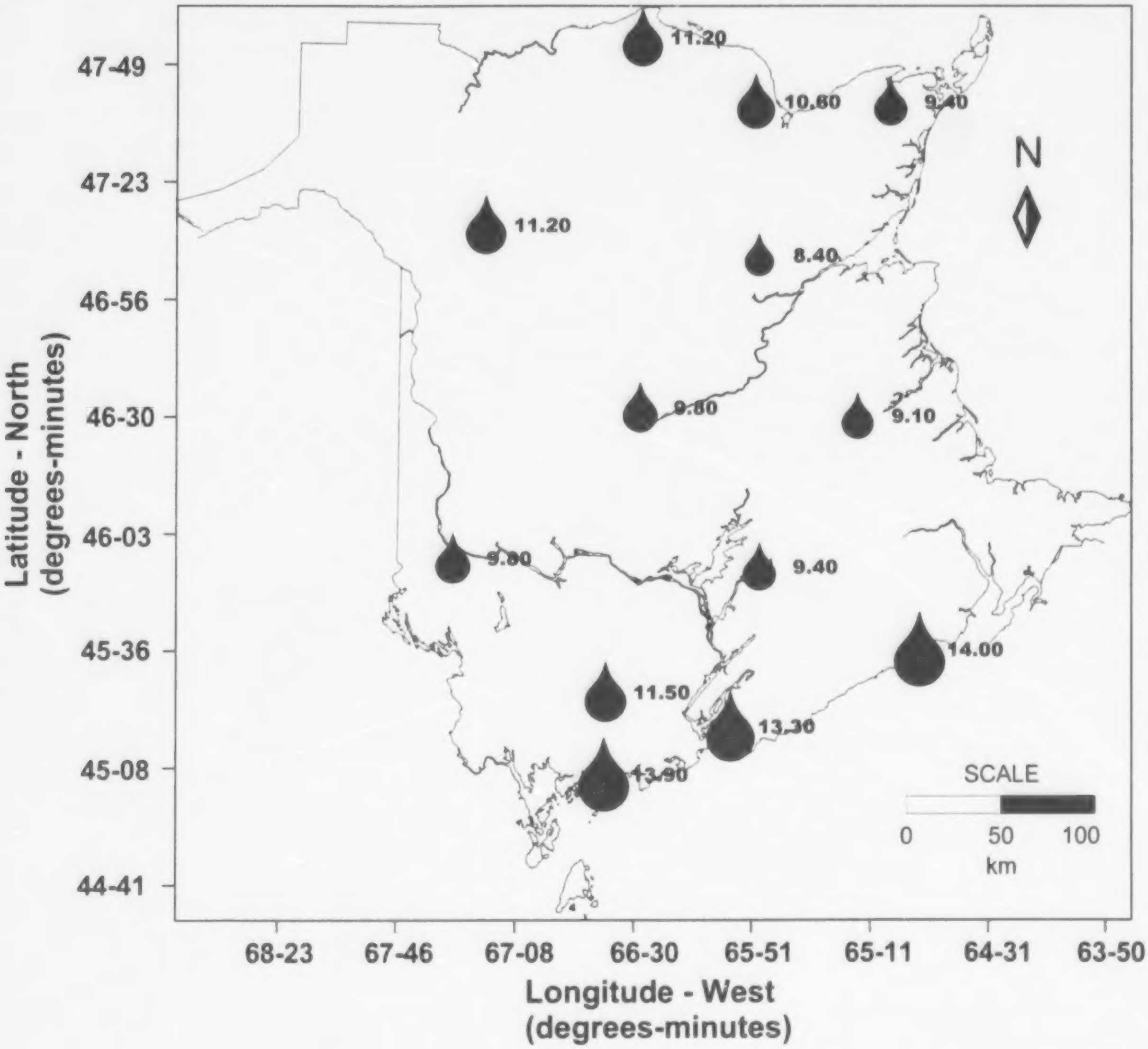

11.20
10.60
9.40
11.20
8.40
9.80
9.10
9.80
9.40
14.00
11.50
13.30
13.90
N
SCALE
0
50
100
km
47-49
47-23
46-56
46-30
46-03
45-36
45-08
44-41
Latitude - North (degrees-minutes)
68-23
67-46
67-08
66-30
65-51
65-11
64-31
63-50
Longitude - West (degrees-minutes)

Figure 15. Acid Deposition for 1999 (kilograms per hectare per year of sulphate). The droplet symbols are sized in proportion to the deposition measured at that site.

A. New England Governors/Eastern Canadian Premiers Acid Rain Action Plan

Since the early 1980's the New England Governors/Eastern Canadian Premiers (NEGECP) have met annually to discuss items of regional interest, such as trade, tourism and the environment. In the 1980's and early 1990's this collaboration led to significant efforts to address the acid rain issue, and develop emission control programs.

In June 1998, the Governors and Premiers met in Fredericton, New Brunswick, and reaffirmed their concern that the acid rain issue was still a concern in the northeastern region. As a result of the meeting, a detailed Acid Rain Action Plan was drafted, listing 22 recommendations. Work has begun under this plan to fill gaps in existing knowledge, improve data sharing, establish new monitoring networks and review emission control efforts. Working groups have been established to address the following items: data collection and management, monitoring of surface water quality and fine particulates in air, forest mapping, sulphur and nitrogen control strategies, and public awareness and education.

The NEGECP held their 1999 annual meeting in October in Rockport, Maine. During 1999, work began on a new Communications Plan to inform the public of the activities of the NEGECP and about the impacts of acidification.

Focus was maintained on producing new emission reduction targets and schedules for acidifying gases in each nation. Work continued on projects focussing on forest mapping, data exchange, surface water quality, and fine particulate monitoring. Work progressed on a number of scientific review papers dealing with the role of nitrogen in acidification and the predicted effects of future emission controls.

A working demonstration was developed of a mapping project to provide real-time information on ozone in the northeastern United States and Canada, made available through the internet (World Wide Web). The Fine Particulate subgroup of the NEGECP continued to work on development on this project, expected to be launched in summer 2000.

Plans were made during the year to transfer several new fine particulate monitors, known as Federal Reference Method (or FRM) monitors, to the Atlantic Provinces. These units measure $PM_{2.5}$ and should be operational during 2000.

B. Canada-Wide Acid Rain Strategy for Post-2000

In October 1998, this strategy was signed by the Ministers of Environment and Energy of all provinces and territories. The Post-2000 Strategy updates efforts which have been going on since the mid 1980's to reduce emissions which contribute to acid rain. Efforts from 1985 to date have reduced sulphur dioxide emissions in eastern Canada by 50% from 1980 levels. The Post-2000 strategy contains plans to reduce acid-causing emissions even further, recognising that although progress has been made, more reductions are still needed to enable critical loads to be reached. The strategy also provides direction for other activities such as scientific monitoring and research, and it makes a formal commitment to seek further reductions in sulphur dioxide emissions from the United States.

During 1999, a comprehensive review was undertaken to examine the adequacy of Canada's scientific work on acid rain. An expert panel of scientists from Environment Canada, Alberta, Ontario, Quebec, New Brunswick and Nova Scotia managed the review. A number of meetings of stakeholders were held across the region, which were useful in obtaining ideas and opinions from a broad range of data users, policy makers and researchers. The review identified significant gaps in the current science and monitoring program, and indicated areas where efforts need to be directed in order to fill those gaps. To address these conclusions and recommendations of the review, federal and provincial governments are undertaking an examination of costs and funding options for a revitalized science and monitoring program.

Additional work included negotiations with the United States on additional commitments to emissions reductions under the Canada-US Air Quality Agreement, planning and consultation work towards setting new emissions targets in Canada, and formal reporting of emissions, with future projections, for all of Canada.

13. LONG TERM AIR POLLUTION TRENDS

In addition to examining air quality monitoring results for a given year, it is often informative and revealing to compare annual results to previous years, and consider longer term trends. This provides information on how air quality may be changing over the years, and whether emission control measures as applied to industrial operations and consumer products (notably vehicles) are influencing long term environmental quality. As mentioned in the introduction, air quality monitoring has been ongoing in parts of the province since the 1970's, especially in the Saint John region. In this section, data for key locations with long-term records are presented to provide information on air quality trends.

A. Carbon Monoxide

The only long term site for this substance is the Customs Building site in uptown Saint John. The earlier part of the record (prior to 1991) is from the nearby Post Office location. Results are predominantly influenced by motor vehicle emissions. Results show that since 1980, the annual average has changed relatively little. There are signs of a possible decrease from 1980 to the mid 1990's, and an increase since then, although the variability between years reduces the confidence that these are meaningful patterns. During the period in question the population of

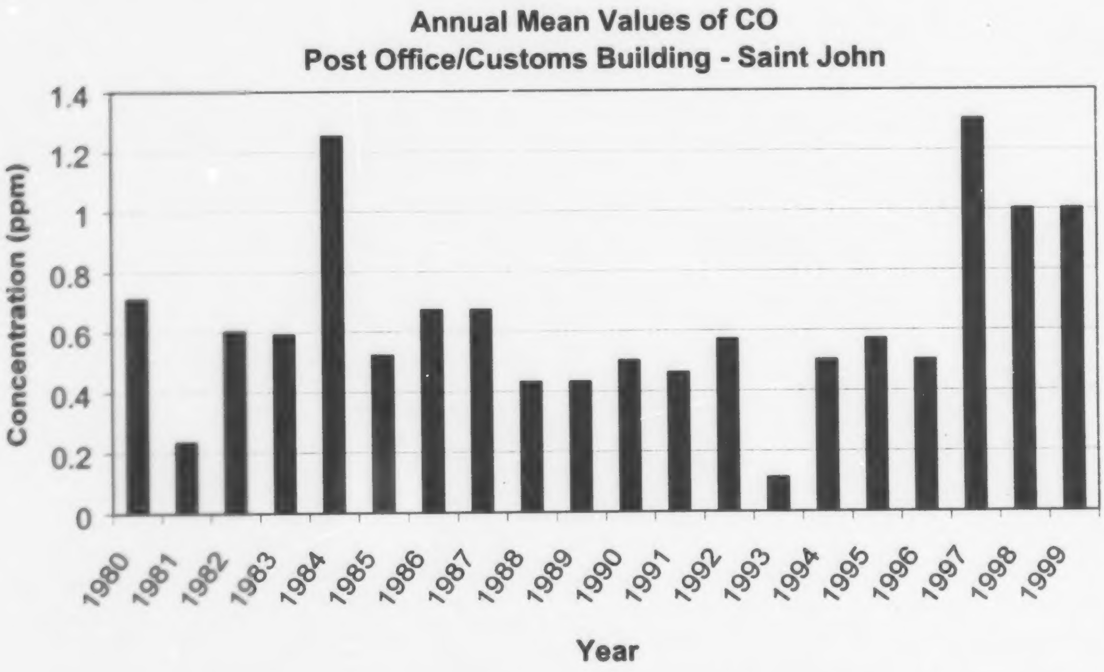


Figure 16. Annual mean values of carbon monoxide, Post Office/Customs Building, Saint John, 1980-1999.

Saint John has increased approximately 4% (Aldighieri, 1998). The number of vehicles registered and more notably, the average total kilometres driven each year, have been increasing throughout the 1990's (Goggin, 1999; Transport Canada, 1999; Statistics Canada, 1999). These pressures, which tend to increase carbon monoxide emissions, have been offset by a greater proportion of vehicles on the road fitted with emissions control equipment, such as catalytic converters. It remains to be seen whether the higher values in the past few years are the beginning of a persistent trend.

B. Nitrogen dioxide

Forest Hills

Nitrogen dioxide is another key pollutant emitted by motor vehicles, as well as industrial sources. The trend at Forest Hills, in suburban east Saint John, appears to be downward since 1981, with little variation between years since 1987. The annual level in 1999 was the lowest since 1993. Forest Hills is influenced by emissions from local industries as well as the more diffuse sources such as vehicles.

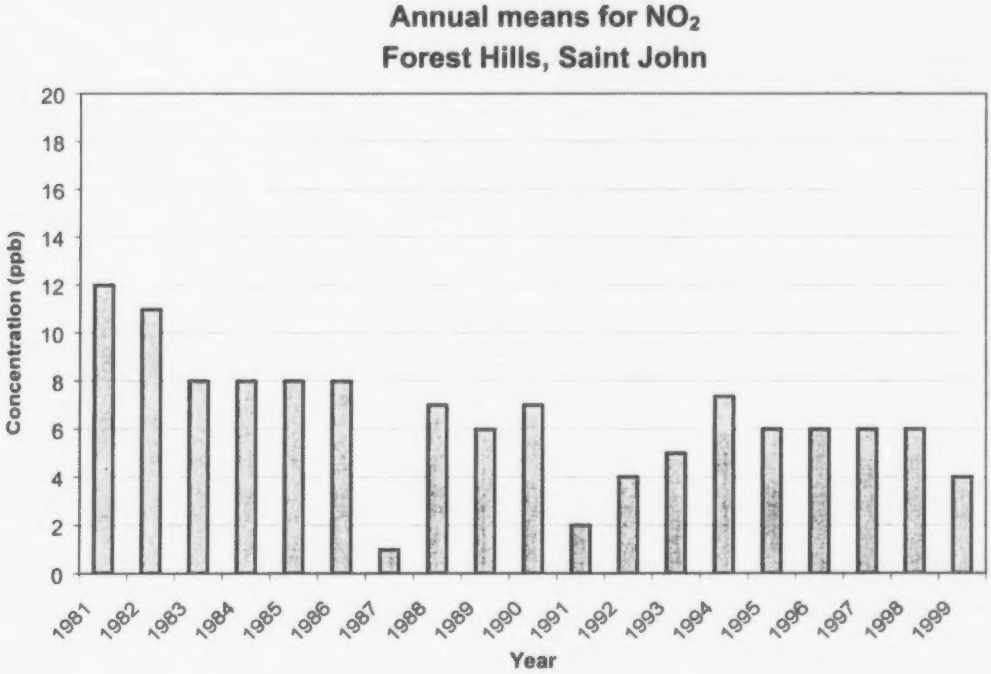


Figure 17. Annual mean nitrogen dioxide at Forest Hills, Saint John, 1981-1999.

Customs Building

Nitrogen dioxide levels appear to be stable or decreasing in recent years, following an increase from the early 1980's to 1987. In 1999, the annual mean at this uptown location was slightly higher than in 1998, but similar to most years since the early 1990's. There is no clear evidence of a progressive trend since 1992.

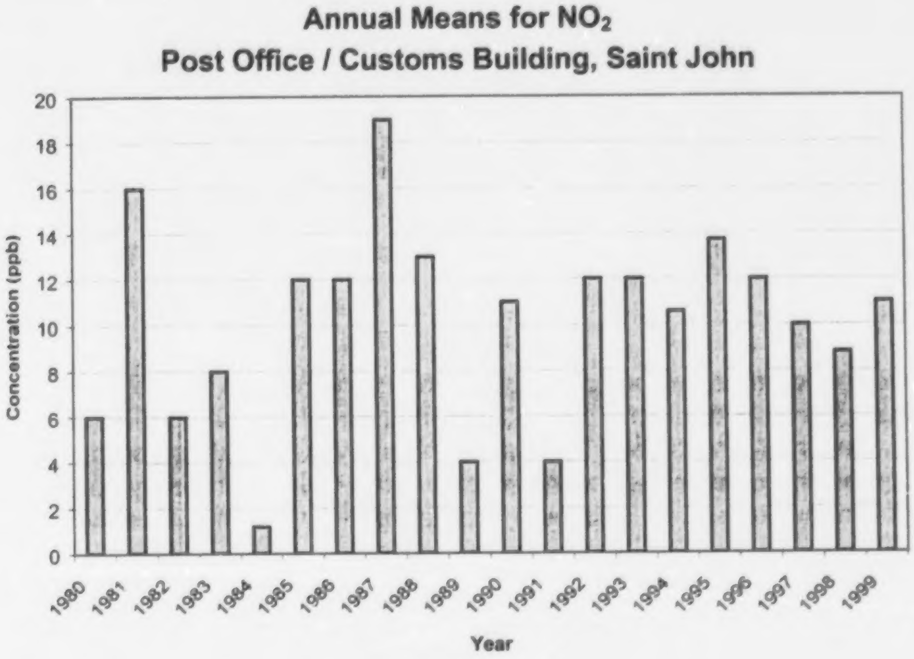


Figure 18. Annual mean nitrogen dioxide at Customs Building, Saint John, 1980-1999.

C. Sulphur dioxide

Forest Hills

Air quality monitored at the Forest Hills site in east Saint John is influenced by several local industries. Considering the trend since 1976, annual average concentrations have twice increased and decreased over the 22 year period, from 1976 to 1987 and from 1987 to 1996. In the past three years, an increasing trend has become apparent, although concentrations are still considerably lower they were in the late 1970s and early 1980's. This is due to a number of factors, including changing generation patterns at the Courtenay Bay generating station and reduced emissions from the pulp and paper sector. Other influences on sulphur dioxide levels at the site include emissions from the oil refinery and possibly the Coleson Cove generating station.

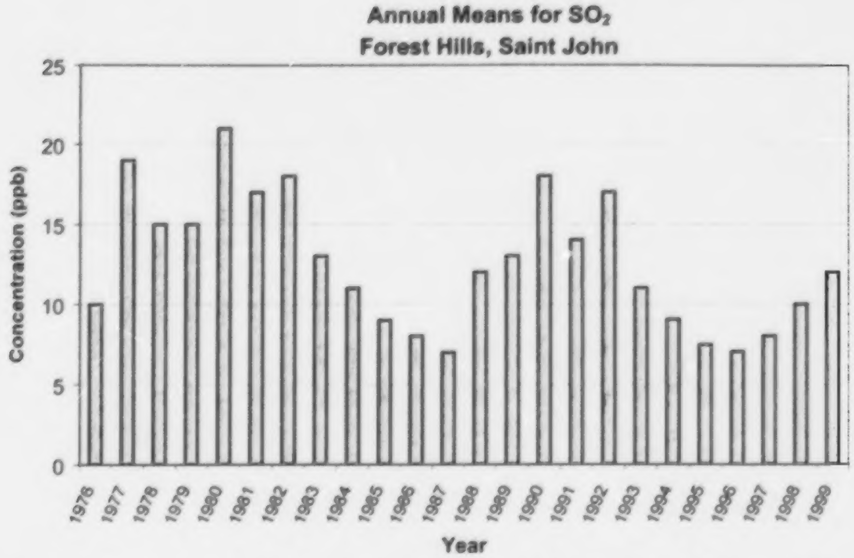


Figure 19. Annual mean sulphur dioxide at Forest Hills, Saint John, 1976-1999.

Customs Building

In uptown Saint John, as represented by records from the Post Office and Customs Building sites, the sulphur dioxide trend since the mid-1970's has been overwhelmingly downward. Recently, levels have been approximately 30% of those common in the early 1980's. Decreasing concentrations in this part of the city are probably due to reduced emissions from the Reversing Falls pulp and paper mill, which fell by about 70% from

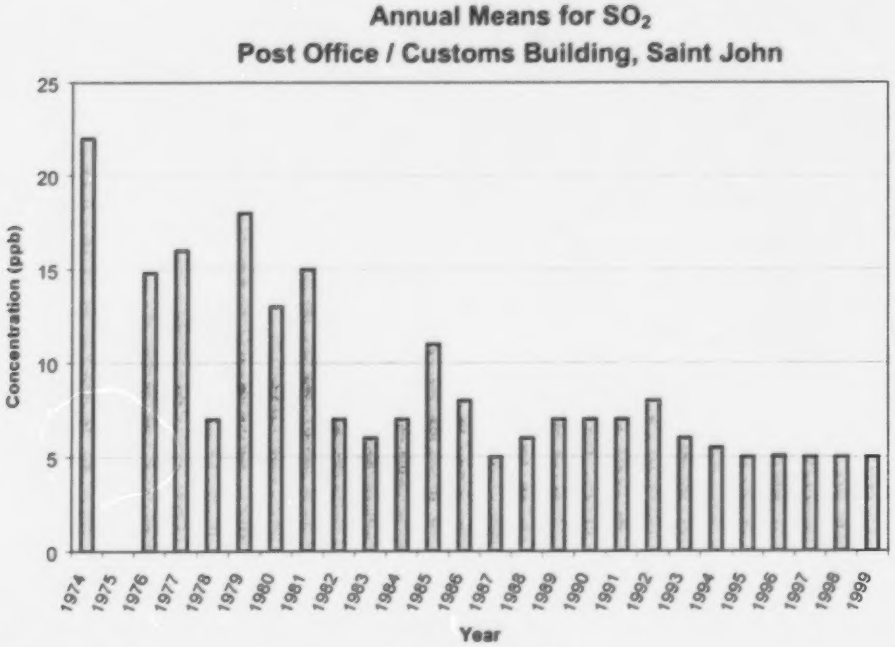


Figure 20. Annual mean sulphur dioxide at Post Office/Customs Building, Saint John, 1974-1999.

1980 to 1995. Reduced emissions from the NB Power Courtenay Bay generating station (down 74% from 1990 to 1995) may also be partly responsible. The annual mean in 1999 was the same as that for the previous four or five years.

D. Ozone

As explained in section 11, ozone is a regionally transported pollutant which is not emitted directly from smokestacks or tailpipes, but which forms in the air when other pollutants mix and react together. As such, trends in ozone are due to changing emissions of the pollution ingredients that are required for ozone to be made (nitrogen oxides and volatile organic compounds) over a large upwind area of eastern Canada and the United States. Seasonal weather, especially summer conditions, also has a major influence on the amount of ozone affecting New Brunswick.

Forest Hills

At Forest Hills, ozone levels have not changed significantly over the past 19 years. There have been some years such as 1984 and 1988 which had higher values, but there is no overall trend either up or down. The 1999 data confirmed this, with an annual average typical of that seen over the past 10 years.

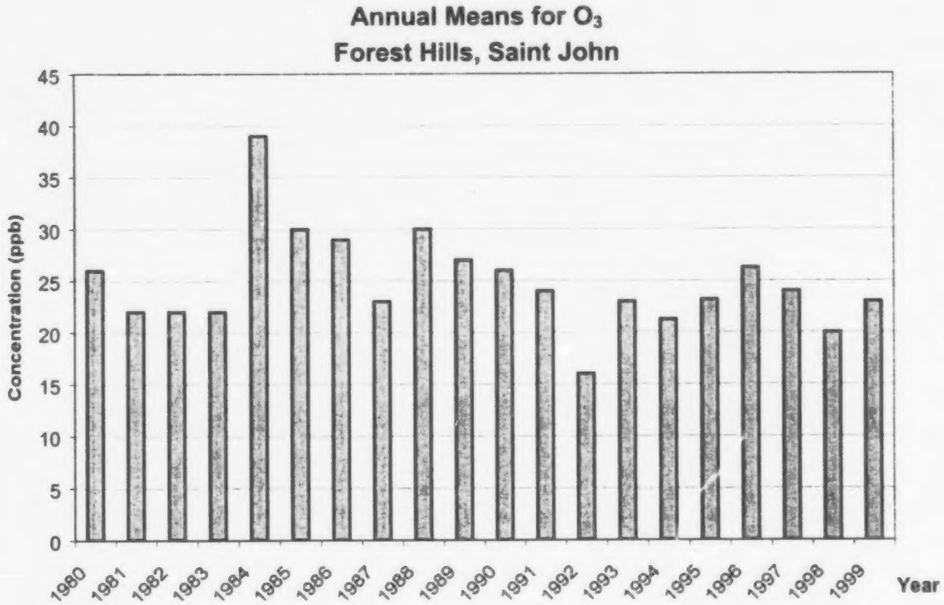


Figure 21. Annual mean ozone at Forest Hills, Saint John, 1980-1999.

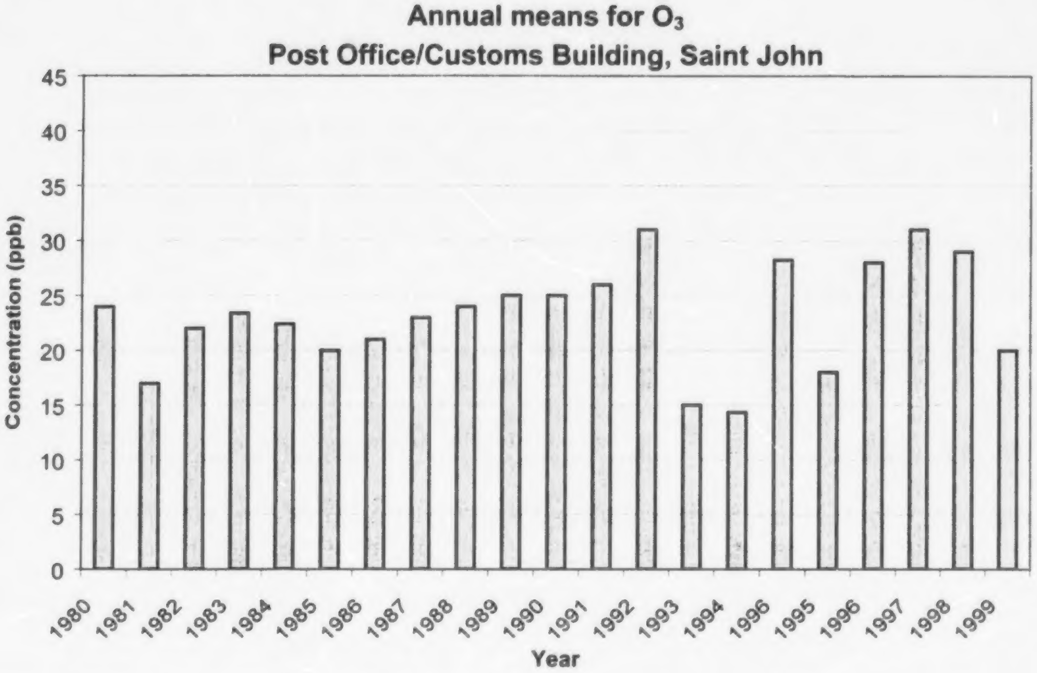


Figure 22. Annual mean ozone at Post Office/Customs Building, 1980-1999.

Customs Building

At the Customs site, annual averages for ozone have been variable since the early 1990's. Taking the most recent results into account, there is no clear trend to be seen over the period of record.

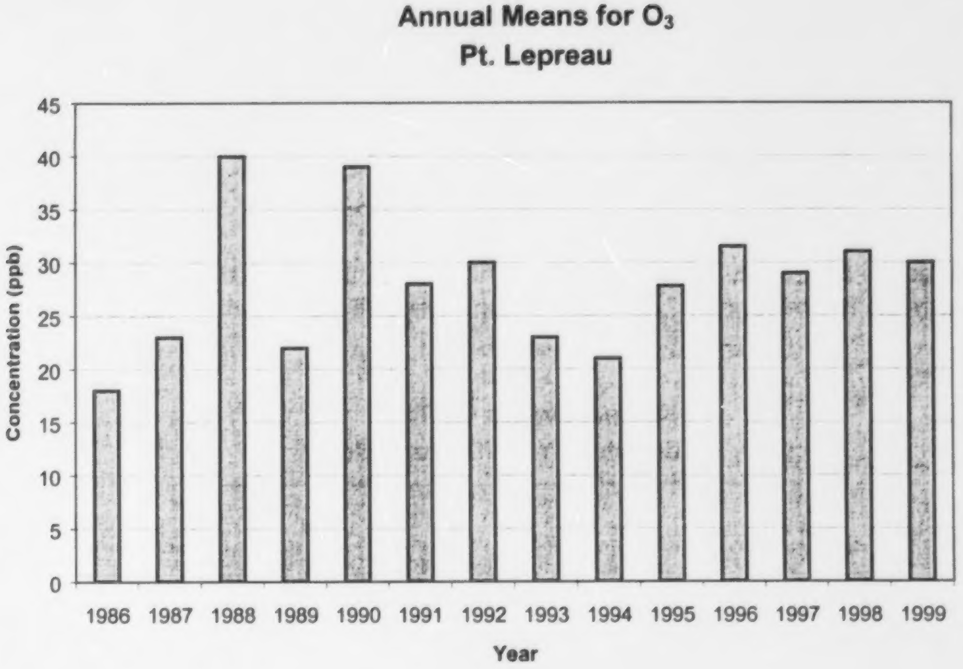


Figure 23. Annual mean ozone at Point Lepreau, 1986-1999.

Point Lepreau

Data for this site are included to provide a perspective from a rural location which is almost always upwind of major sources of air pollutants in southern New Brunswick. Annual ozone levels are somewhat higher than those seen in the Saint John area. This is due to the lack of other emissions which react with and remove ozone from the air (mainly nitric oxide).

The record at Point Lepreau reveals considerable variability between years and the indication of a possible upward trend since 1986. The 1999 results were similar to those of the previous five years. Due to the complex relationship between ozone, its precursor compounds and weather conditions, it is very difficult to evaluate the significance of apparent trends in ozone. Within a given geographic area it is not unusual to find different trends at different sites, even though all may be apparently influenced by the same weather and pollution transport conditions. Local site factors are probably important.

E. Total Suspended Particulate

Sites which had measured TSP in Saint John ceased operation in 1999. Efforts to monitor particulate matter will in future concentrate more on the measurement of specific particulate size fractions ,such as PM_{10} and $PM_{2.5}$.

Fredericton

A long term record for particulate has been maintained at the fire hall on York and Dundonald streets in Fredericton. The site is representative of most of the downtown region.

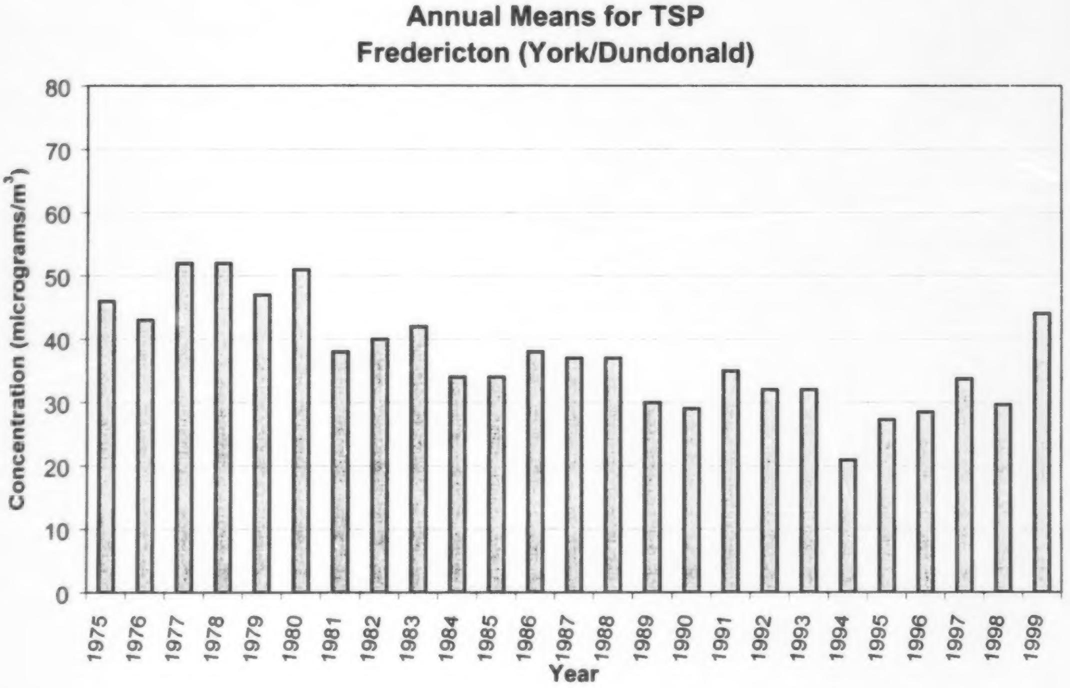


Figure 24. Annual mean total suspended particulate, Fredericton, 1975-1999.

The Fredericton data reveal a long term decreasing trend. Levels in recent years are about 50-60% of what they were in the late 1970's/early 1980's. Although elevated readings are still seen occasionally - which appear to be due to road dust and possibly also woodsmoke from domestic stoves - the overall trend is clearly downward. 1999 figures were up somewhat, inflated by a number of very high readings in the fall and winter. These high values appear to have been due to the influence of nearby construction activity.

F. Inhalable particulate (PM_{10})

Provincial Building

PM_{10} particulate matter has been measured at a small number of locations, all in Saint John, starting in 1984. The longest records are from the Provincial Building and Forest Hills sites. Data from these locations are presented here. Averaging over five years, data from the Provincial Building show a decline from 24.5 to 19.5 micrograms/cubic metre from 1984-88 to 1994-98. This decline is consistent with the decrease in total suspended particulate over the same period. The annual average in 1999 was up, and was in fact the highest yet recorded. The reasons for this are not easy to decide with certainty, but the high level of construction activity in the Saint John area in 1999 may have had a significant effect.

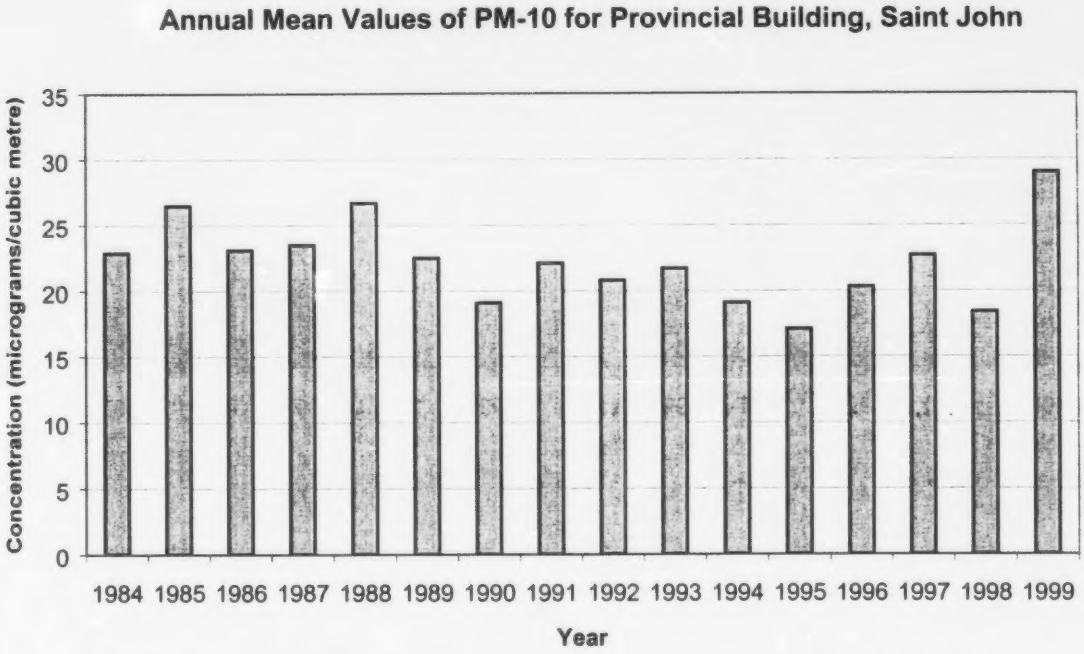


Figure 25. Annual mean PM_{10} at Provincial Building, Saint John, 1984-1999.

Forest Hills

The data from Forest Hills show a proportionally greater drop than those at the Provincial Building - almost 50% since 1989. Due to the effect of dust (especially road dust) on PM_{10}, some variation between years is to be expected, due to changes in weather (for example, the frequency of dry, windy conditions). In 1999 the annual average was (as for the Provincial Building station) the highest on record, and probably for the same reason. Major construction activity in east Saint John - for example that associated with the refinery upgrade - is likely to have influenced PM_{10} levels.

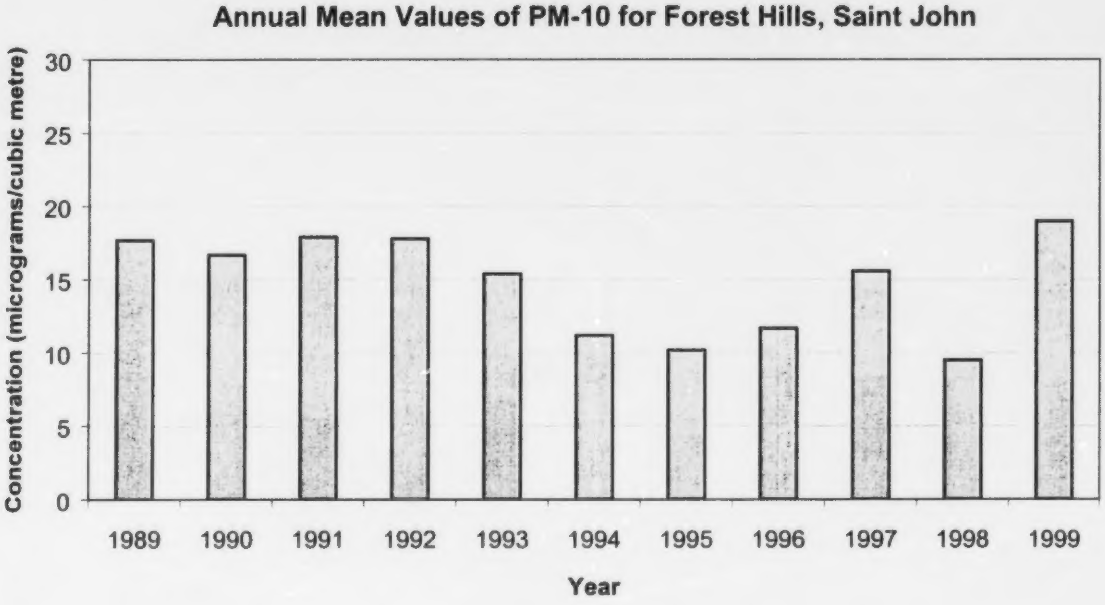
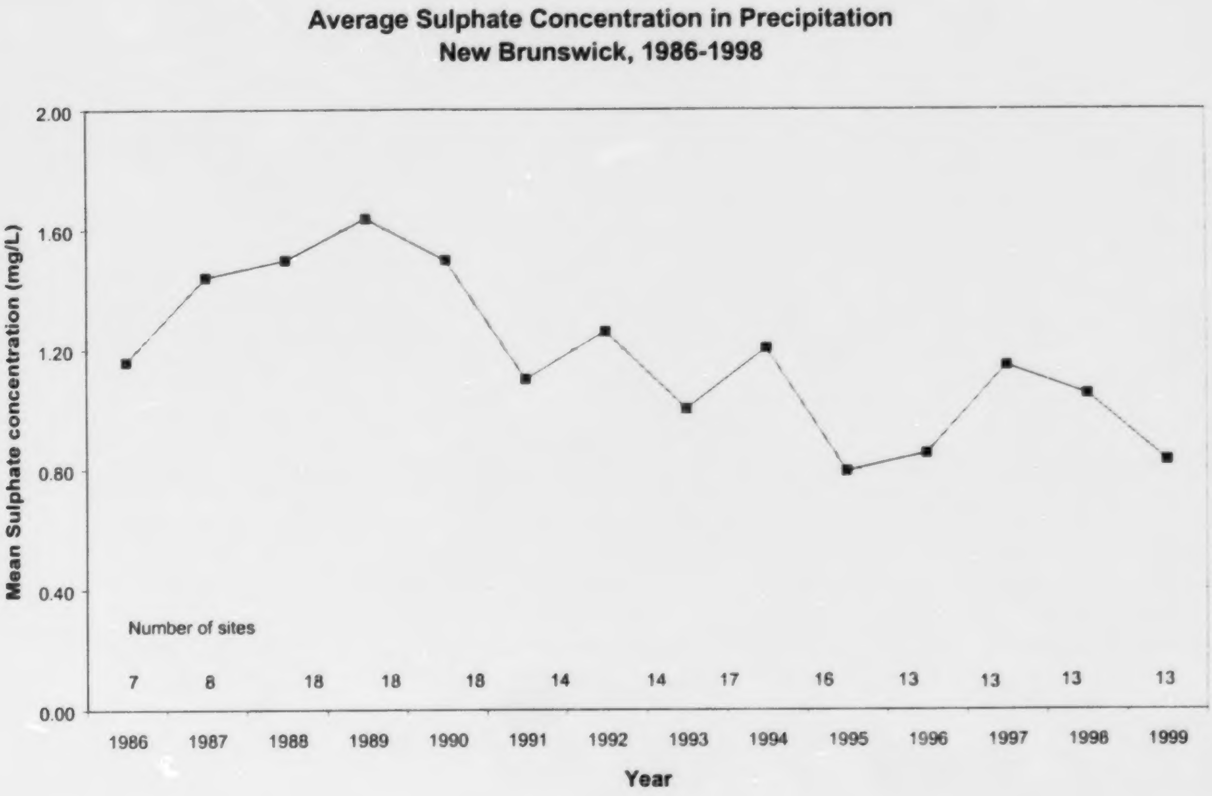


Figure 26. Annual mean PM_{10} at Forest Hills, Saint John, 1989-1999.

G. Acid Rain

Since 1986, 27 separate sites have been operated for monitoring acid deposition across New Brunswick. Provincial coverage is presently maintained with 13 sites. To provide a statistic which can give some indication of long term changes or trends, the annual average sulphate concentration in precipitation was averaged across all sites operating in each year. The results are shown in the accompanying chart, which also shows the number of sites operating in each year. The apparent trend is downward since 1989. This is expected, based on reductions in sulphur dioxide emissions in eastern Canada and the United States in the same time period.



Average Sulphate Concentration in Precipitation
New Brunswick, 1986-1998

Figure 27. Network-wide mean annual sulphate concentration in precipitation in New Brunswick, 1986-1999.

H. Volatile Organic Compounds

VOCs have been measured at two locations (Forest Hills and Point Lepreau) since 1992, as noted in section 10. Routine analyses provide results for over 150 VOCs. Trends for selected VOCs are presented here.

One clear finding of the VOC sampling program is that concentrations of most VOCs are substantially higher at Forest Hills than at Point Lepreau. This is consistent with the location of Forest Hills in an industrial urban setting and Point Lepreau in a relatively remote, rural situation.

Figure 28 shows trends in average total VOC concentrations for both sites since 1992.

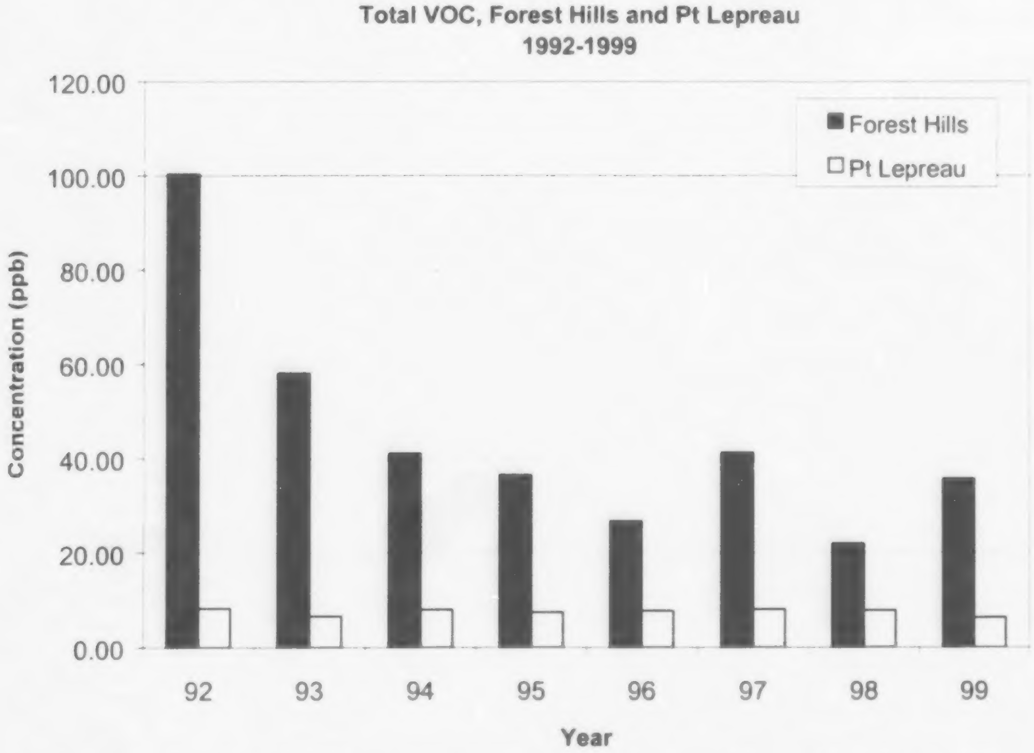


Figure 28. Average total VOC concentration at Forest Hills and Point Lepreau, 1992-1999.

These results clearly show the difference in average VOC levels between the sites, as well as a significant downward trend in total VOC since 1992 at Forest Hills. There has been relatively little change at Point Lepreau. The decrease at Forest Hills is due to reduced levels of many individual compounds characteristic of industrial influence. Emissions from the refinery complex clearly influence the Forest Hills location, and levels of compounds such as butane and isopentane, which are major components of gasoline vapour, have shown a downward trend over the measurement period (Figure 29). There is a suggestion that the downward trend from 1992 to 1998 may have reversed in 1999. Future trends will be closely examined for changes following major new engineering work at the refinery during 1999-2000.

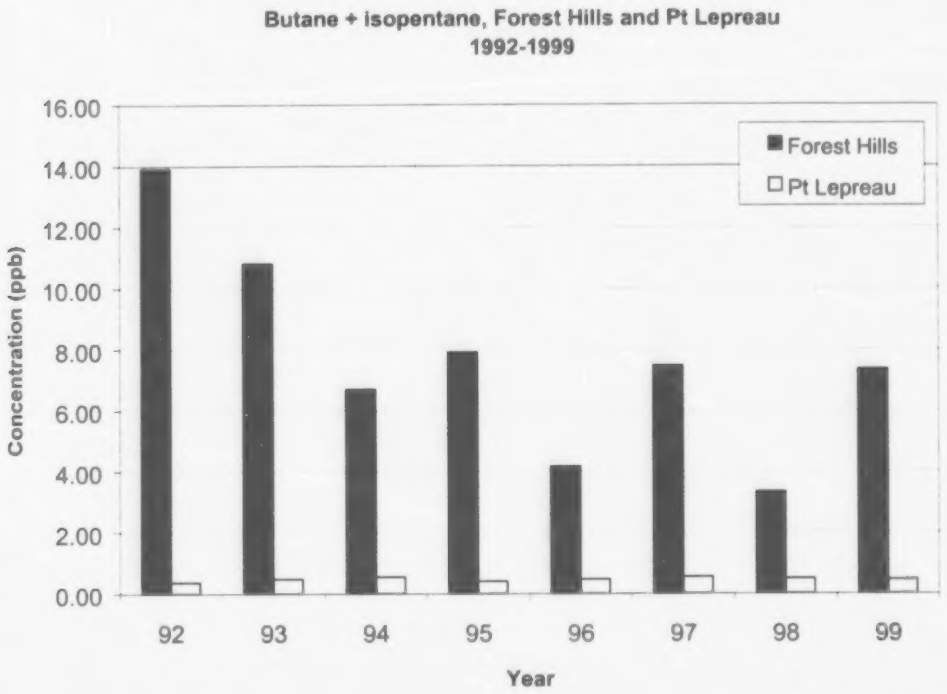


Figure 29. Annual average concentration of butane plus isopentane at Forest Hills and Point Lepreau, 1992-1999.

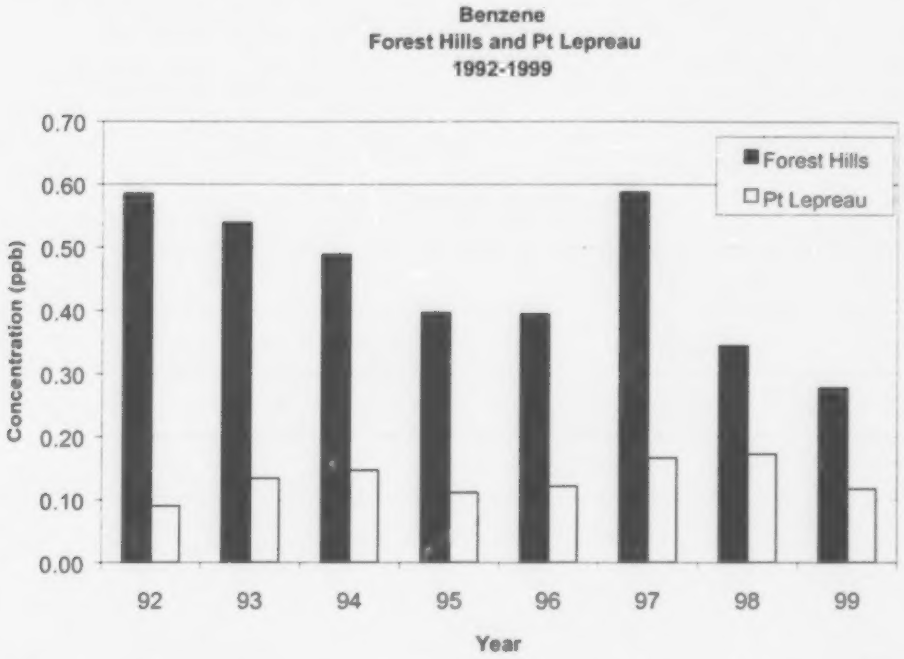


Figure 30. Annual average concentration of benzene at Forest Hills and Point Lepreau, 1992-1999.

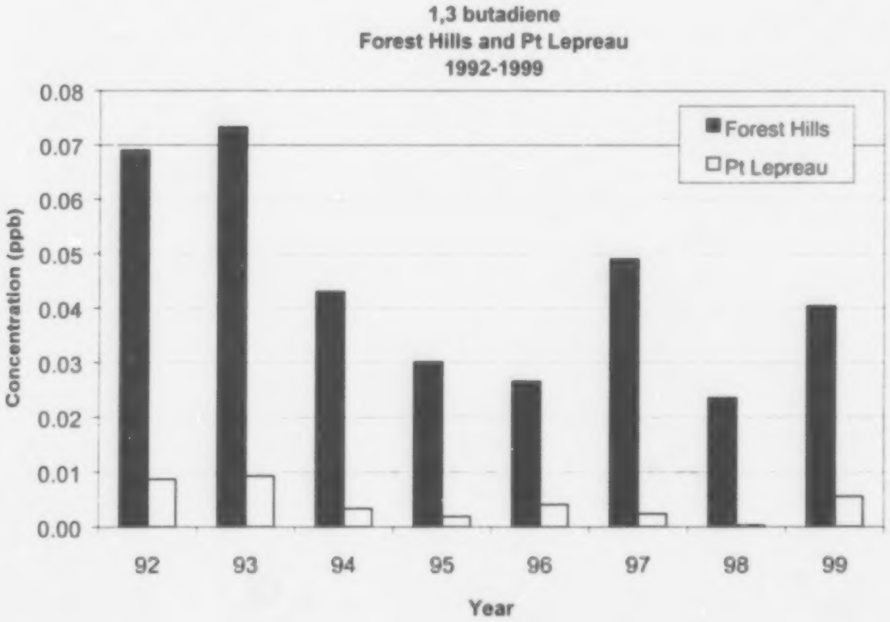


Figure 31. Annual average concentration of 1,3 butadiene at Forest Hills and Point Lepreau, 1992-1999.

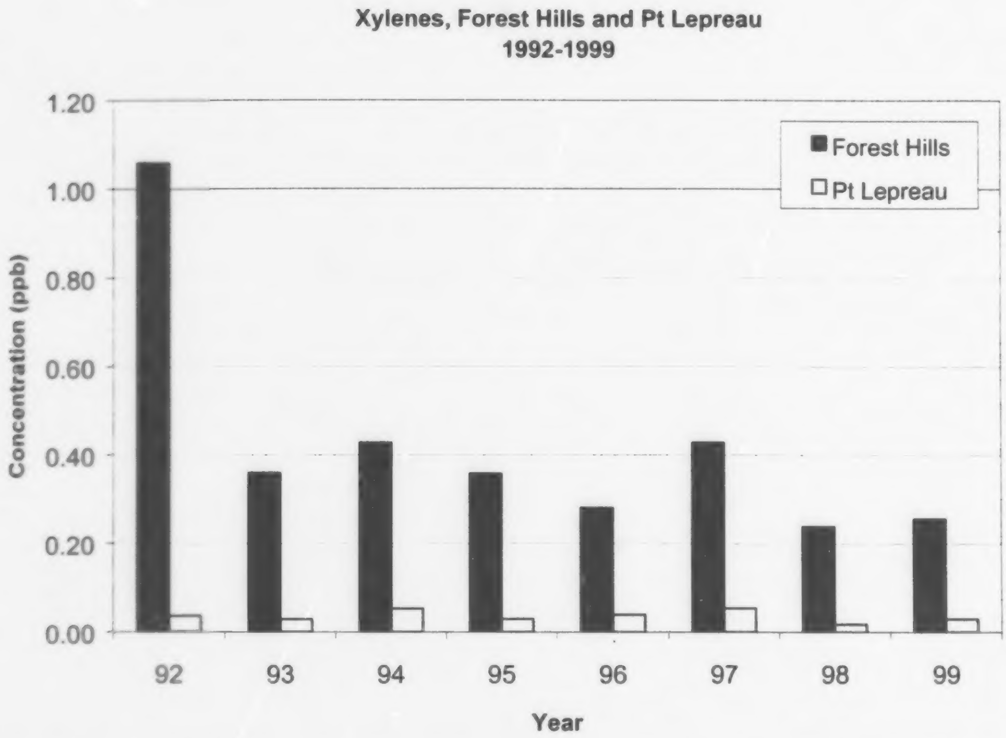


Figure 32. Annual average concentration of xylenes at Forest Hills and Point Lepreau, 1992-1999.

Some potentially toxic VOCs also show a generally decreasing trend at the Forest Hills monitoring site. Figure 30 shows the trend for benzene, Figure 31 for butadiene and Figure 32 for xylenes. In each case there is little apparent trend at the rural Lepreau site, and a decrease at the suburban Forest Hills location. Benzene is an important component of gasoline, and xylenes are associated with vehicle exhaust (Multistakeholder NOx/VOC Science Program, 1997a). Butadiene is emitted during petroleum refining and subsequent handling, as well as from internal combustion engines (e.g. CARB, 1992). The oil refinery began a leak repair program in 1995, designed to reduce VOC emissions from leaking equipment such as pumps and valves. This may have been a factor in the observed decreases of many VOCs, although the bulk of the decrease took place between 1992 and 1995. Other changes may have had some influence, such as an increasing proportion of vehicles on the road being equipped with emission control devices.

APPENDIX I: GLOSSARY OF TERMS AND ABBREVIATIONS

micrograms/m^3	Microgram (of contaminant) per cubic metre (of air).
Two-way catalytic converter	A device fitted to motor vehicle exhaust systems which reduces their output of air pollutants. A 2-way converter is designed to reduce the carbon monoxide and hydrocarbon emissions. Fitted to new light duty motor vehicles sold in Canada after 1974.
Three-way catalytic converter	A 3-way converter reduces nitrogen oxides (NOx) from motor vehicle exhaust, in addition to the pollutants removed by a 2-way catalytic converter. Fitted to new light duty motor vehicles sold in Canada after 1987.
Acidic deposition	The input of acidic pollutants to the environment, usually expressed as kilograms per hectare per year of acid-forming substances such as sulphates and nitrates (see acid rain).
Acid rain	A term which refers to rain (and snow) which has become abnormally acidic due to the effects of acidifying gases such as sulphur dioxide and nitrogen dioxide.
Acid aerosols	Very small (usually invisible) airborne particles which contain acids.
Acidification	The process by which lakes, rivers or whole drainage basins can be adversely affected by continued inputs of acid rain.
Act	A broad piece of legislation which provides authority to government departments and Ministers to develop more specific regulations and policies, and carry out related enforcement activities.
Aerosol	When referring to air pollution, aerosol means small suspended particles in the air, which may be natural or resulting from human activities.
Air quality Index	A near real-time information system providing the public with an indication of overall air quality, expressed as a single number (usually on a 0-100 scale). The index takes into account measurements of several pollutants.

Ambient air	Outdoor air.
Approval to Operate	A permit issued to businesses which tells them what they must do to comply with environmental protection requirements. For example these permits specify allowable emissions of various substances, how often reports must be made to the NBDOE, what these reports must contain, and mandatory annual testing.
ARMA committee	Air Resource Management Area Committee. Several such committees have been formed in New Brunswick since 1994, to examine local air quality issues and submit recommendations to the Minister of the Environment.
Asthma	A disorder of the respiratory system, associated with difficulty in breathing.
Bronchitis	Inflammation of the small bronchial tubes in the lungs, which may be associated with breathing difficulties, discomfort or coughing.
Carbon monoxide	Abbreviation: CO. A colourless, odourless, toxic gas formed when fuels burn inefficiently.
CO	Carbon monoxide.
Cardiovascular	Having to do with the heart and blood circulation system.
Catalytic converter	In a motor vehicle, a device for converting harmful exhaust gases into less harmful substances. These converters use a chemical catalyst which causes the chemical conversion to take place. See 2- and 3-way catalytic converter.
Certificate of Approval	See Approval to Operate.
Clean Air Strategy	A policy document of the NBDOE, published in 1993, reviewing air quality in New Brunswick and setting out directions for future efforts to improve it.
Corridor	In air pollution terminology, refers to a region through which prevailing winds frequently pass, carrying air pollutants. For example the Windsor-Quebec City corridor, the Washington-Boston corridor.

Critical load	Referring to acid rain, the amount of acid input a region can receive which results in no long term adverse affects to at least 95% of its lakes.
Emphysema	A condition in which the air sacs in the lungs are abnormally enlarged, causing lack of breath.
Episode control program	An agreed-upon system of actions to be taken by an industry or other source or air contaminants, designed to prevent the occurrence of exceedances.
Exceedance	When referring to air pollution, an occasion on which a specified air quality standard or objective was surpassed. Note that hourly exceedances refer to measurements made over standard clock hours.
Geometric mean	A way of calculating a meaningful average from data which contains extreme values.
Ground level ozone	Ozone found in the air in the lower atmosphere, including the air we breathe. See ozone.
Guideline	A recommended value, but one which usually does not have the force of law. See objective.
H_2S	Hydrogen sulphide.
Hydrocarbon	A compound containing only hydrogen and carbon. For example methane, propane and butane are all hydrocarbons.
Hydrogen sulphide	Abbreviation: H_2S. A toxic gas, smelling powerfully of rotten eggs, detectable by the human nose at very low concentrations. Formed by some paper making processes and also found in sewer gases and naturally in swamps and marshes, where it is produced by decomposing plants.
Inhalable particles	Particles of soot, dust etc., which are small enough that they may enter the lungs without being filtered out by the nose and throat.
IQUA	Index of the Quality of the Air. A system used in Saint John since 1979 to provide the public with a reference indicator for air quality. See Air Quality Index.
kg	Kilogram.

Long range transport	In air pollution terminology, refers to the movement of air pollutants by prevailing winds and weather systems hundreds or thousands of kilometres from where they are released.
Microgram	A millionth of a gram.
Modelling	In the context of air pollution, this terms refers to computer modelling: using simulations of the atmosphere and other natural processes to explore the probable outcome of changing pollution emissions, or the impact of other factors such as weather on pollution levels.
NAAQO	National Ambient Air Quality Objective. Nationally recommended guideline concentrations for air contaminants, designed to provide protection of human health and the environment generally.
NBDOE	The New Brunswick Department of the Environment.
Nitrogen oxides	Compounds of nitrogen and oxygen, primarily referring to nitric oxide and nitrogen dioxide. Abbreviation: NOx.
NOx	See nitrogen oxides.
NO_2	Nitrogen dioxide.
Objective	In the context of air quality, a management goal for environmental protection, usually stated as a number (see the definition for guideline). Objectives may also be broader in nature and expressed as plain language statements. Objectives do not normally have legal force.
Ozone	Abbreviation: O_3. A colourless gas, formed from three oxygen atoms, having a sharp odour at high concentrations. Ozone is very chemically active and can damage living plant and animal cells. Ozone is a major component of photochemical smog, and is formed in this situation by reactions between other air pollutants.
O_3	Ozone
Particulate	A very small piece of soot, smoke or dust; by inference, one which is small enough to become airborne.

Percentile	A statistical term used to classify data according to the frequency of occurrence of a given result. For example, the 50th percentile of a dataset is equal to the mean, or average value. The 75th percentile value is the value which is equal to or greater than 75% of all the measurements contained in that dataset.
Photochemical smog	A mixture of air pollutants usually containing ozone, nitrogen oxides, and particulates. Seen over or downwind of major city areas, typically in hot, sunny weather together with light winds. Often visible against a clear sky as a whitish, yellow or brown cloud or layer.
ppb	Parts (of contaminant) per billion (parts of air).
ppm	Parts (of contaminant) per million (parts of air).
pphm	Parts (of contaminant) per hundred million (parts of air).
PM_{10}	Particulate matter where the individual particles have an effective diameter of 10 microns (millionths of a metre) or less. These particles are small enough to be bypass filtration by the nose and may enter the lungs.
$PM_{2.5}$	Particulate matter where the individual particles have an effective diameter of 2.5 microns (millionths of a metre) or less. These particles may be deposited in the lungs if inhaled.
Radiation balance	The process by which the earth remains at a more or less constant temperature, by radiating as much heat into space as it receives from the sun. So-called greenhouse gases (such as carbon dioxide or methane) affect this balance by slowing down the loss of heat from the lower atmosphere.
Regulation	A formal legal document, made with the authority of an Act, which specifies rules in more technical detail than is given in the Act itself.
Smog advisory	A public information message providing details of expected ground level ozone pollution in the following 24 hours. A smog advisory program has operated in New Brunswick since 1993.

Smog	Originally, a mixture of smoke and fog. Now more often used to refer to pollution mixtures containing ozone and fine particles. See photochemical smog.
SO_2	Sulphur dioxide.
Standard	A numeric value used for the purpose of environmental management: usually refers to an acceptable concentration of a contaminant. Differs from a guideline, goal or objective by having legal force.
Sulphur dioxide	A gas generated when sulphur-containing fuels are burned, having a characteristic, acrid smell. One of the most widespread air pollutants around the world, associated with heavy industry (e.g. smelting, oil refining and major fuel combustion in generating stations).
Target load	Referring to the issue of acid deposition, an interim goal for environmental protection.
TEOM	A type of continuous measuring device for monitoring the particulate content of ambient air. Refers to the measurement principle (Tapered Element Oscillating Microbalance).
TSP	Total suspended particulate.
Total suspended particulate	Abbreviation: TSP. A standard measure of particle concentration in the air. Includes smoke, soot, pollen and other dust from about 0.1 up to approx. 50 microns in diameter.
Trajectory analysis	A method for following the movement of air over long distances, enabling the probable source regions of pollutants to be identified.
VOC	Abbreviation for volatile organic compound. Includes carbon-containing substances which evaporate readily at normal environmental temperatures, examples include gasoline, the solvents in paint, nail polish remover, and many natural VOCs.

APPENDIX II: CANADIAN NATIONAL AIR QUALITY OBJECTIVES

Canadian National Air Quality Objectives

		Sulphur Dioxide	**TSP**	**Carbon Monoxide**	**Ozone**	**Nitrogen Dioxide**	**Hydrogen Sulphide**
		ppb	**$\mu g/m^3$**	**ppm**	**ppb**	**ppb**	**ppb**
Maximum Tolerable Level[1]	1 h				153	532	
	8 h			17.5			
	24 h	306	400			160	
	1 yr.						
Maximum Acceptable Level[2]	1 h	344		30.6	82	213	10.8
	8 h			13.1			
	24 h	115	120		25	106	3.6
	1 yr.	23	70		15	53	
Maximum Desirable Level[3]	1 h	172		13.1	51		0.7
	8 h			5.2			
	24 h	57			15		
	1 yr.	11	60			0.03	

Notes: 1. The maximum tolerable level denotes a concentration of an air pollutant that requires abatement without delay to avoid further deterioration to air quality that poses a substantial risk to public health.

2. The acceptable level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being.

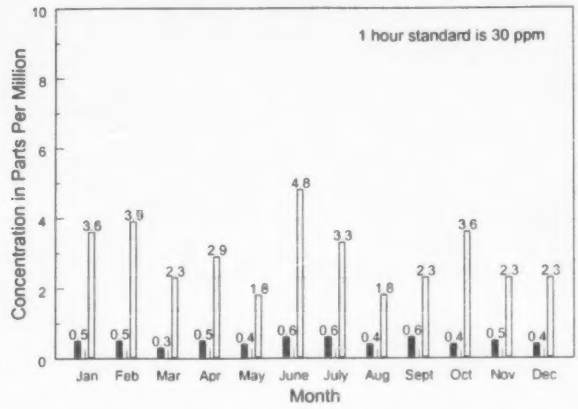
3. The desirable level defines the long-term goal for air quality and provides the basis for an anti-degradation policy for the unpolluted parts of the country.

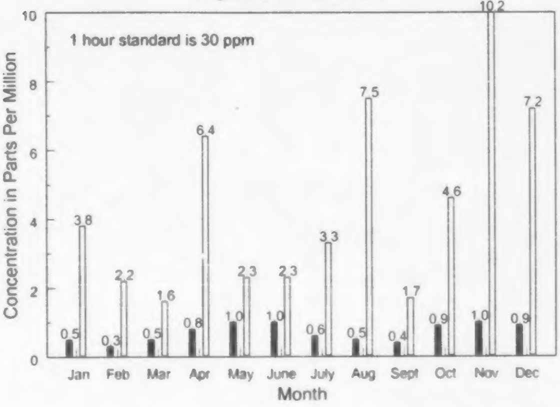
TSP : Total suspended particulate.

$\mu g/m^3$: Micrograms per cubic metre.

APPENDIX III

DETAILED MONTHLY MONITORING RESULTS FOR 1999


Monthly Average & Maximum One Hour Values of Carbon Monoxide in 1999
Customs Building - Saint John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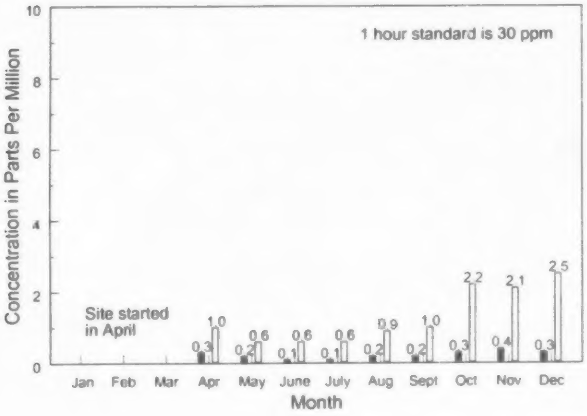
Highfield St. - Moncton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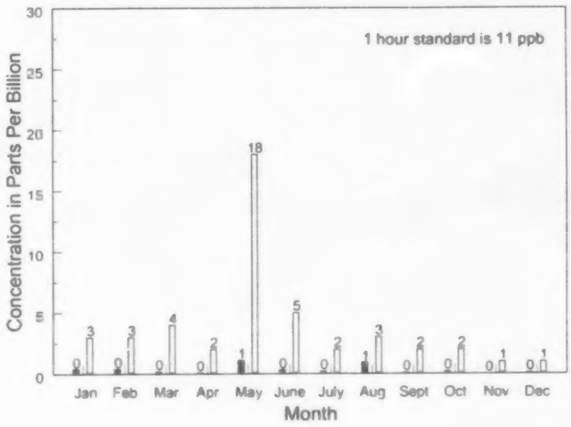
Aberdeen St. - Fredericton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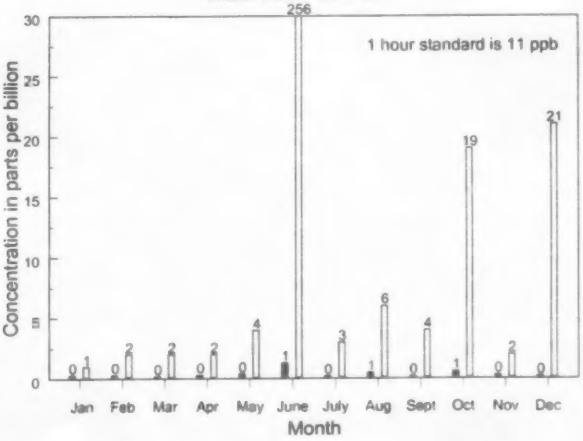
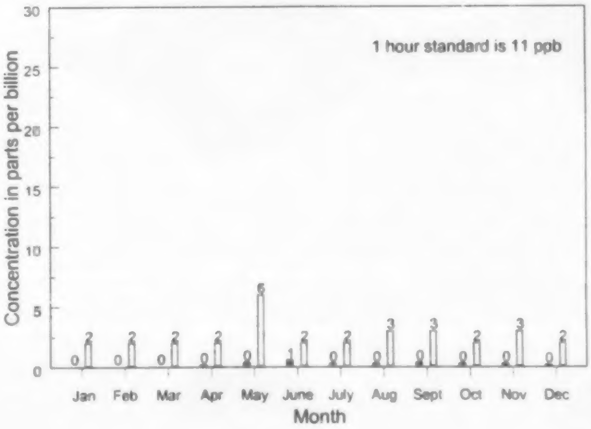
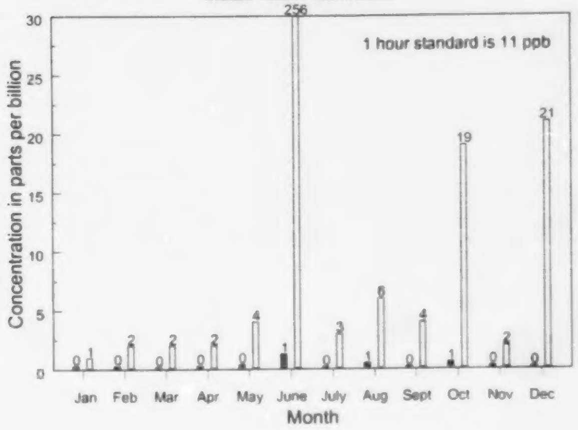
West Side Station (Hillcrest)

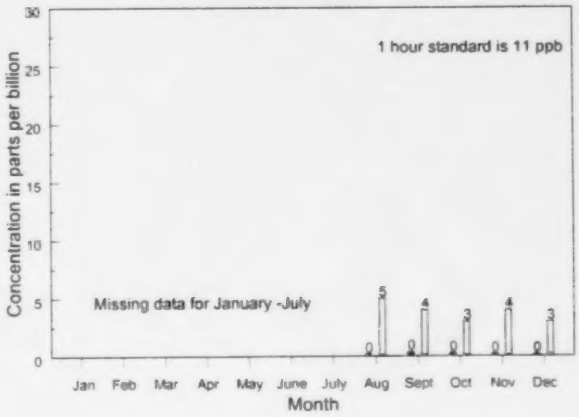

Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
Indian Town - Saint John


Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
Sherbrooke Street - Saint John

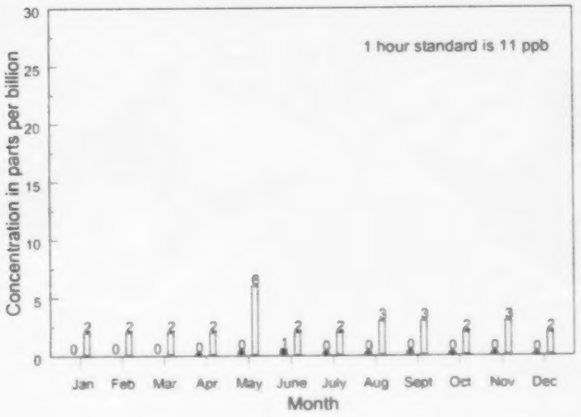
Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
Indian Town - Saint John



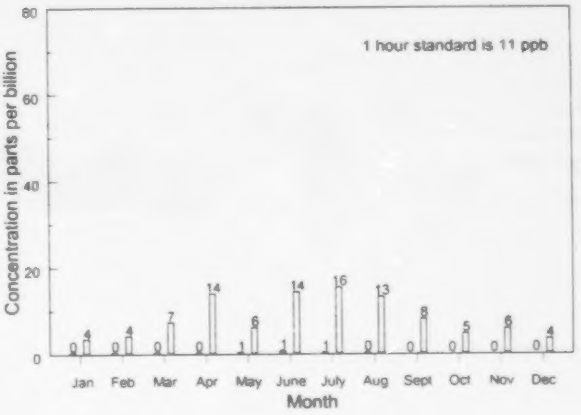
Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
Milford - Saint John



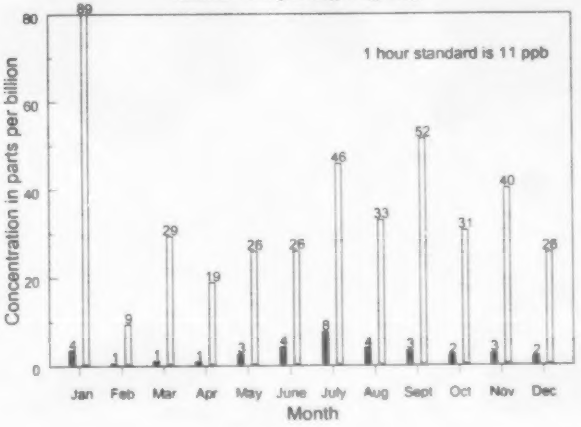
Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
Sherbrooke Street - Saint John



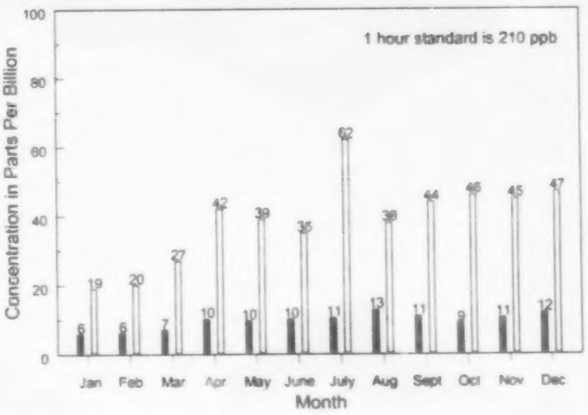
Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
REPAP - Groundwood Mill



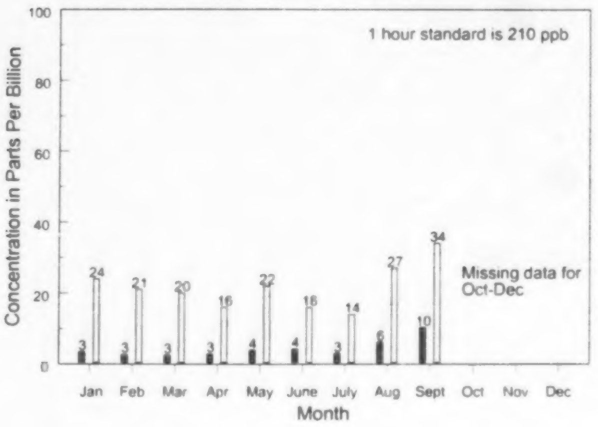
Monthly Average & Maximum One Hour Values of Total Reduced Sulphur in 1999
REPAP - King George Highway



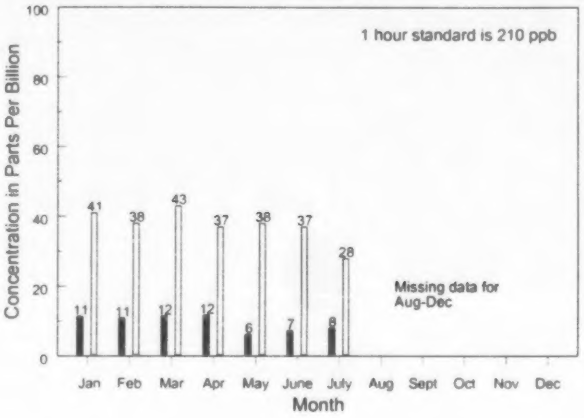
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
Customs Building - Saint John



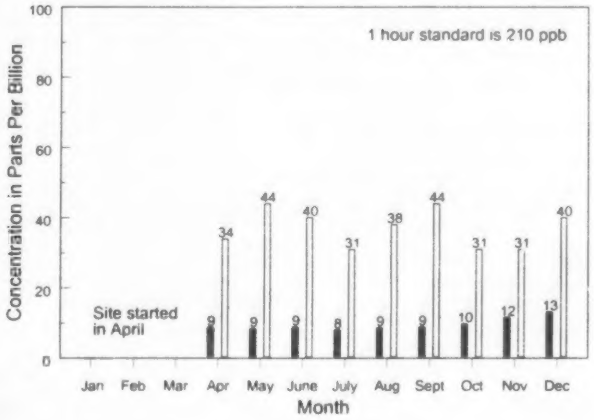
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
Forest Hills - Saint John



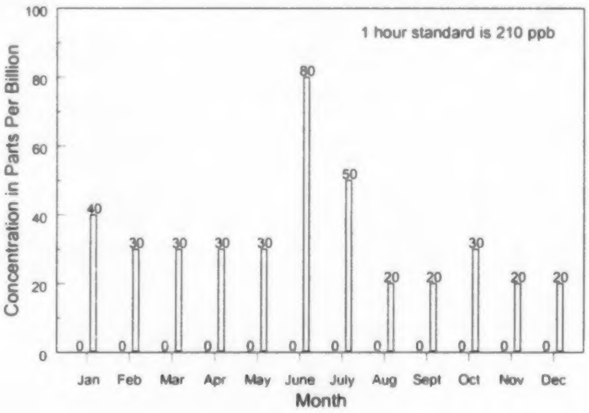
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
Highfield St. - Moncton



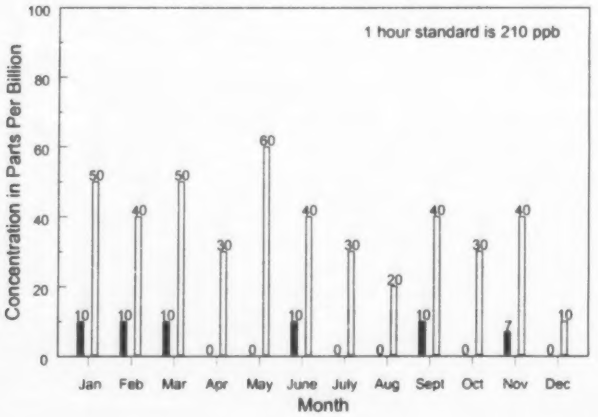
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
Aberdeen St. - Fredericton



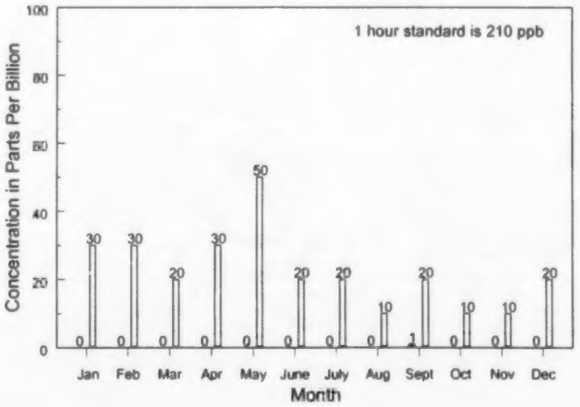
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
NB Power Belledune - Belledune East



Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
NB Power Belledune - Municipal Hall

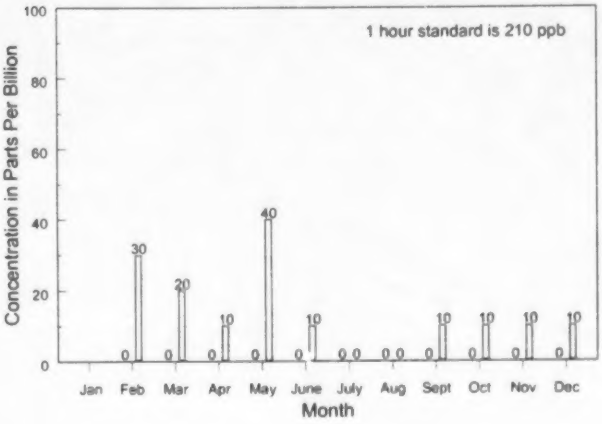


Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999
NB Power Millbank - Rockcliff



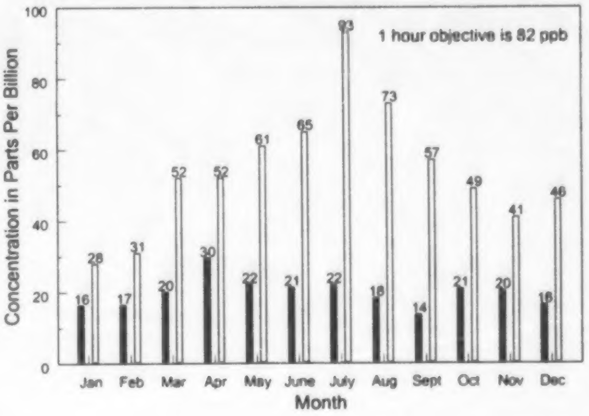
Monthly Average & Maximum One Hour Values of Nitrogen Dioxide in 1999

NB Power Millbank - Lower Newcastle



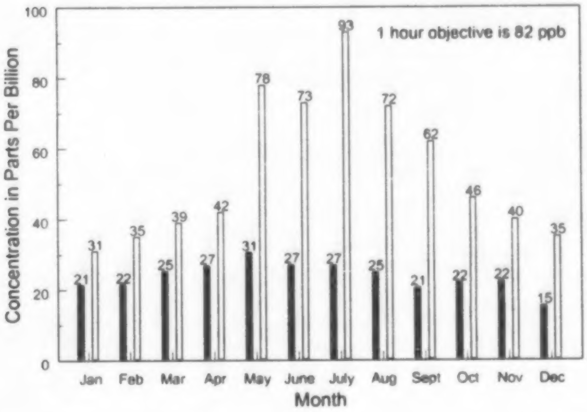
Monthly Average and Maximum One Hour Values of Ozone in 1999

Customs Building - Saint John



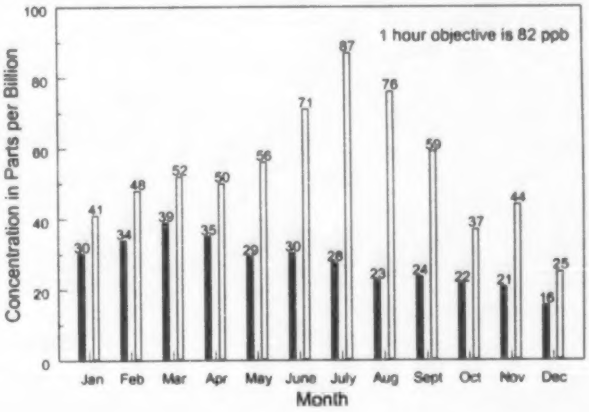
Monthly Average & Maximum One Hour Values of Ozone in 1999

Forest Hills - Saint John



Monthly Average & Maximum One Hour Values of Ozone in 1999

Canterbury



Monthly Average & Maximum One Hour Values of Ozone in 1999

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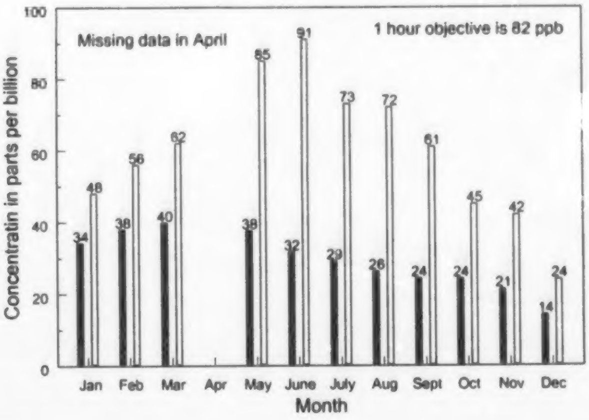
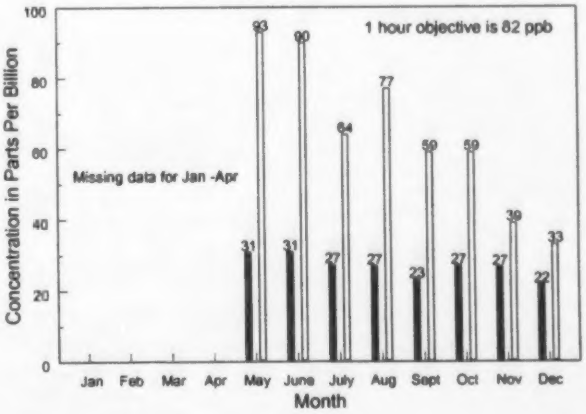
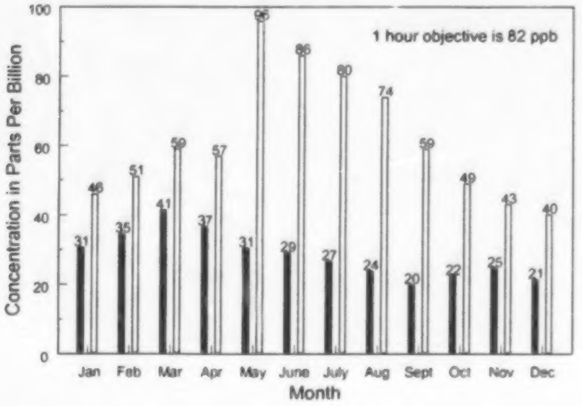


Monthly Average & Maximum One Hour Values of Ozone in 1999

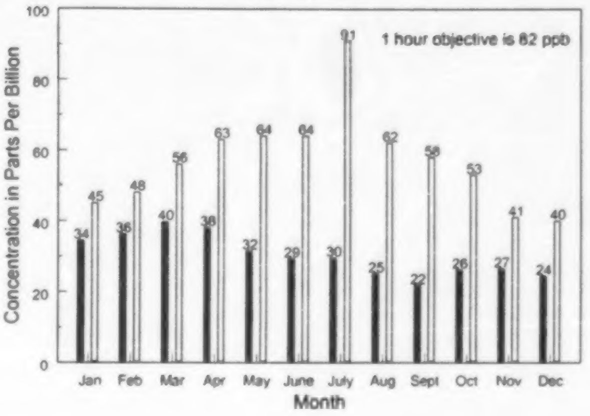
Fundy National Park



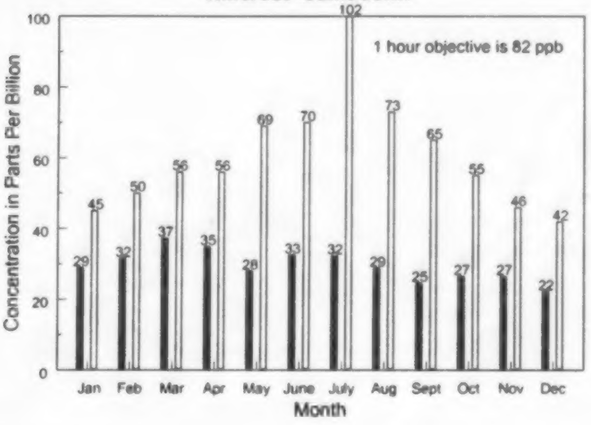
Monthly Average & Maximum One Hour Values of Ozone in 1999
Norton



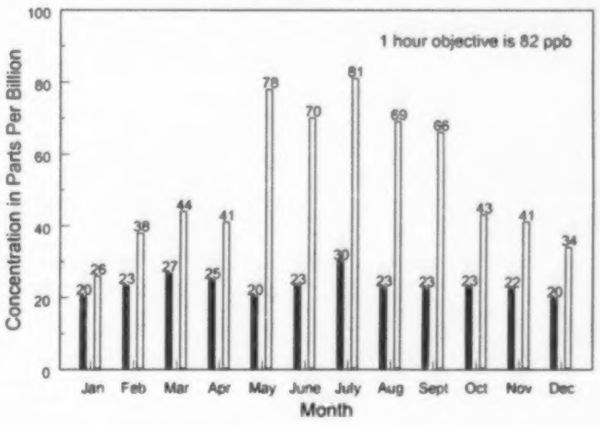
Monthly Average & Maximum One Hour Values of Ozone in 1999
Pt. Lepreau



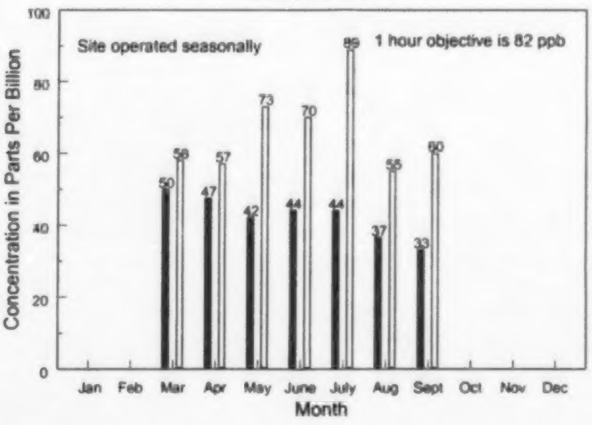
Monthly Average & Maximum One Hour Values of Ozone in 1999
Hillcrest -Saint John



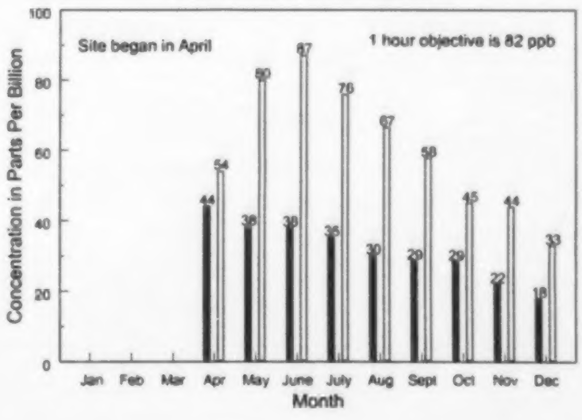
Monthly Average & Maximum One Hour Values of Ozone in 1999
St Andrews

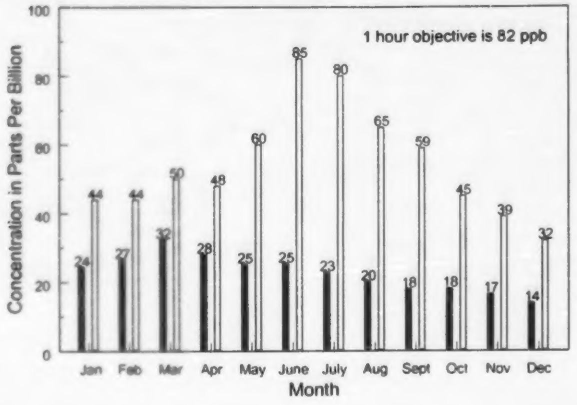


Monthly Average & Maximum One Hour Values of Ozone in 1999
Campobello



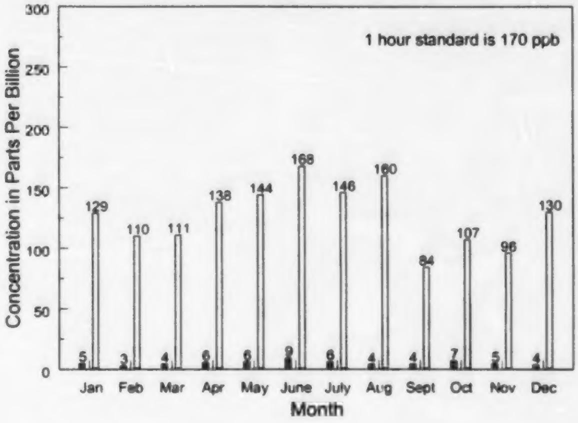
Monthly Average & Maximum One Hour Values of Ozone in 1999
Aberdeen St -Fredericton





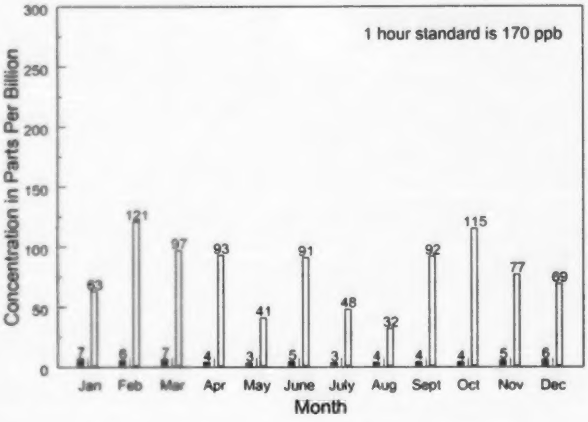
Monthly Average & Maximum One Hour Values of Ozone in 1999

Highfield St - Moncton



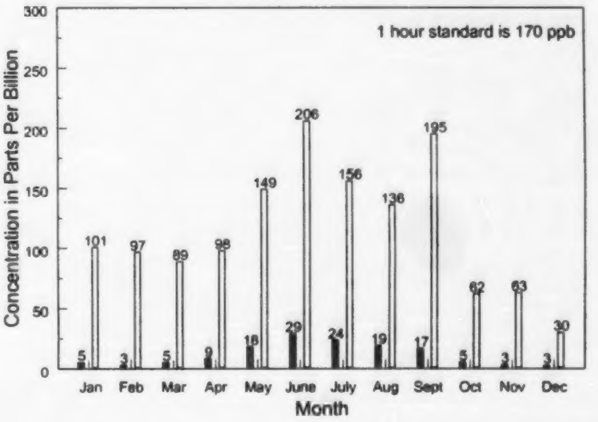
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Champlain Heights - Saint John



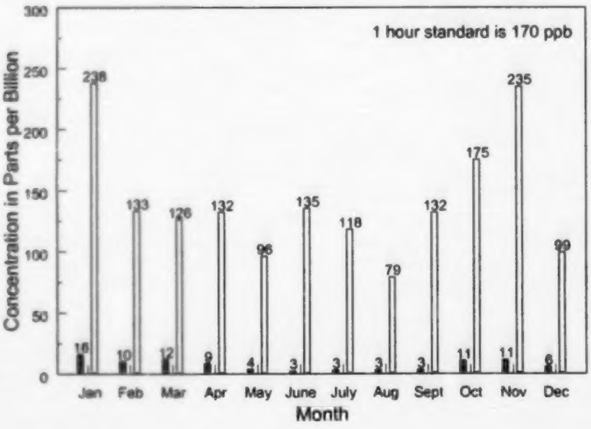
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Customs Building - Saint John



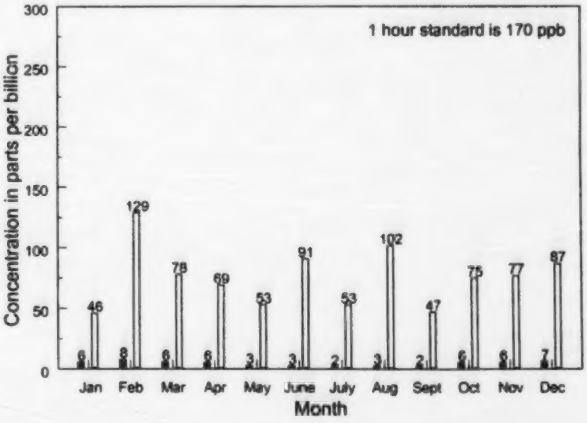
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Forest Hills - Saint John



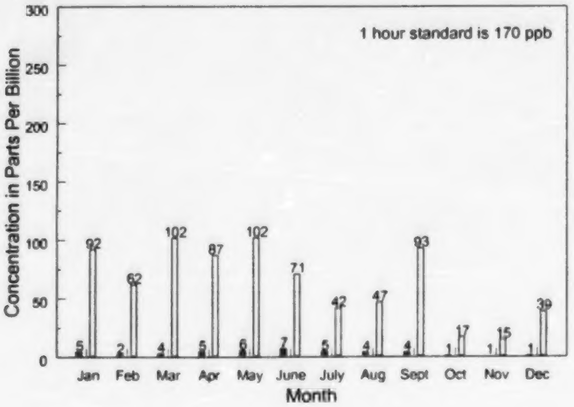
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Forest Products-Saint John

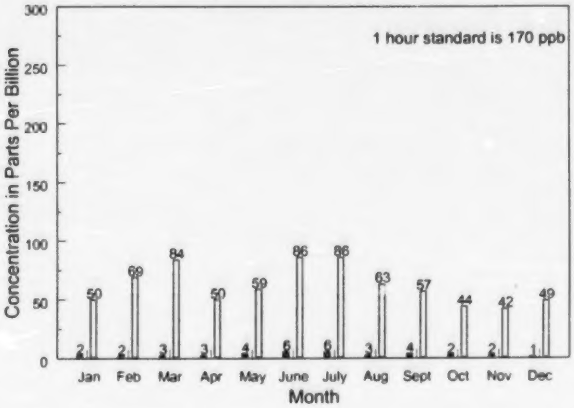


Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

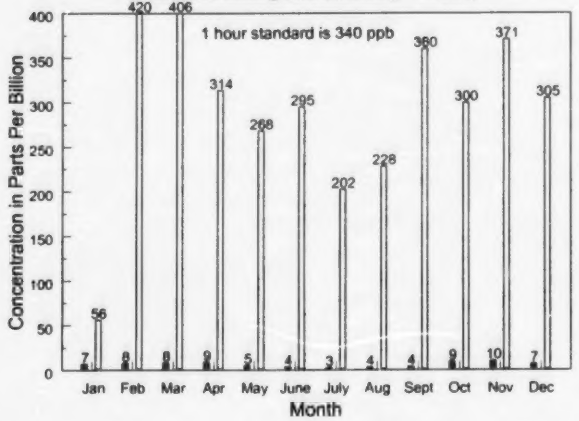
West Side Station (Hillcrest)-Saint John



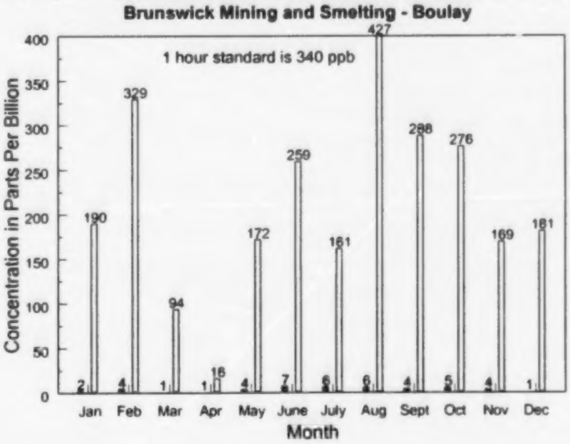
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Silver Falls - Saint John



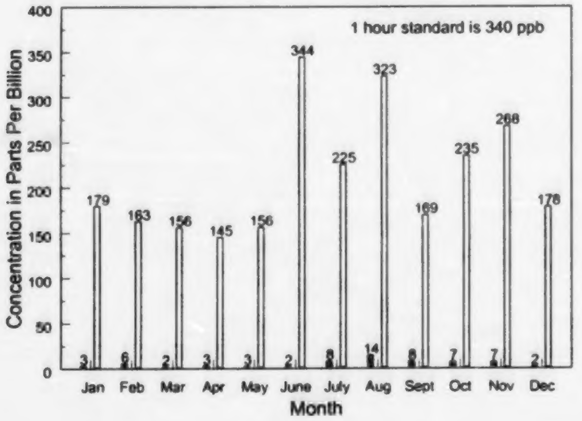
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Three Mile Irving -Saint John



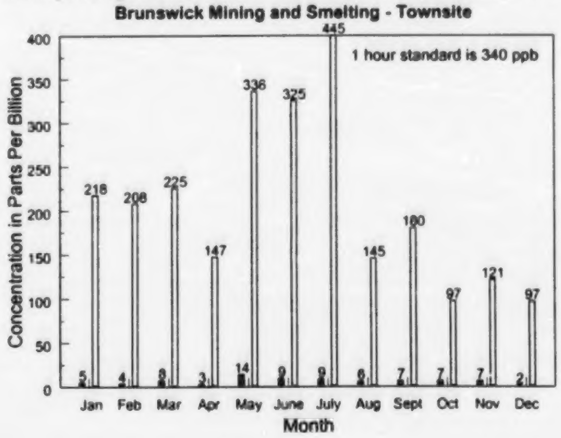
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Brunswick Mining and Smelting - Airstrip



Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Brunswick Mining and Smelting - Boulay



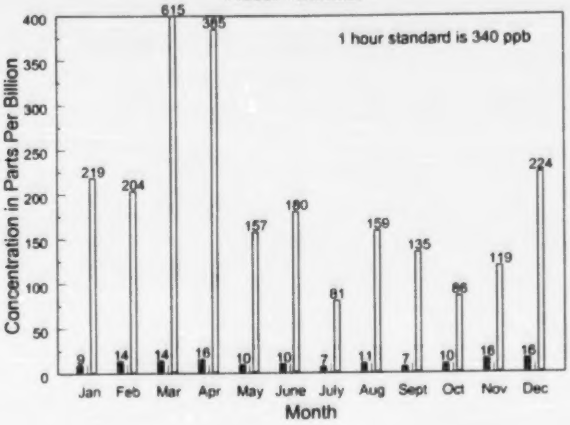
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Brunswick Mining and Smelting - Chalmers



Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
Brunswick Mining and Smelting - Townsite

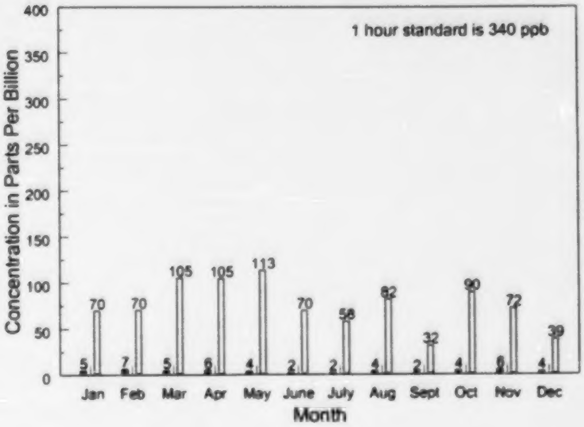
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Fraser - Cormier



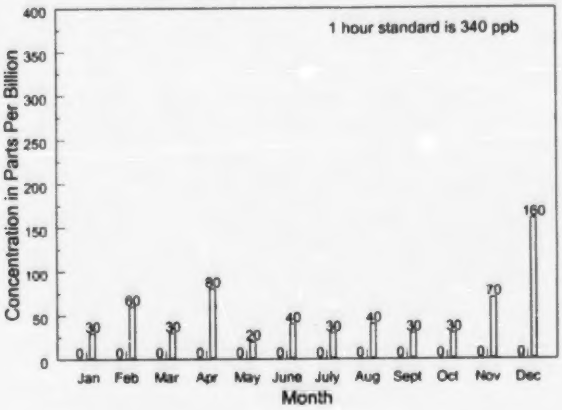
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

Fraser - Sacred Heart



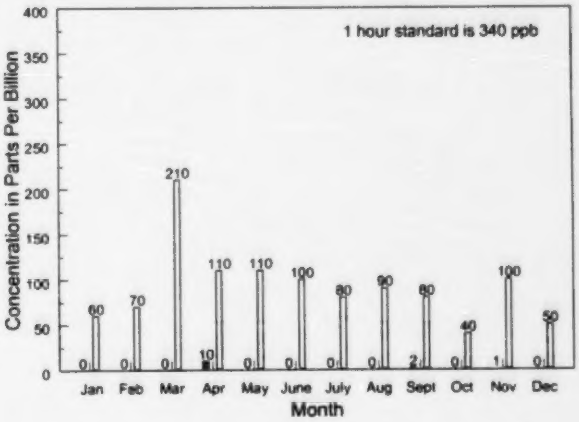
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

NB Power Belledune - Belledune East



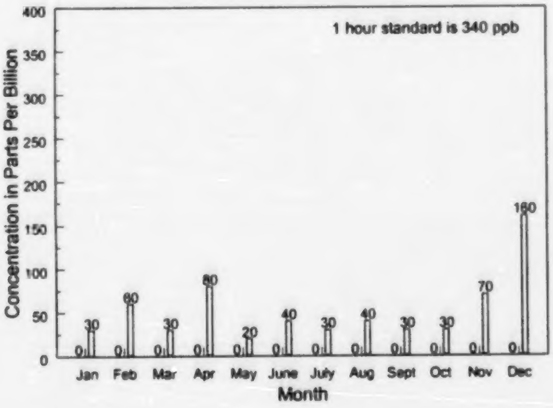
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

NB Power Belledune - Jacquet River



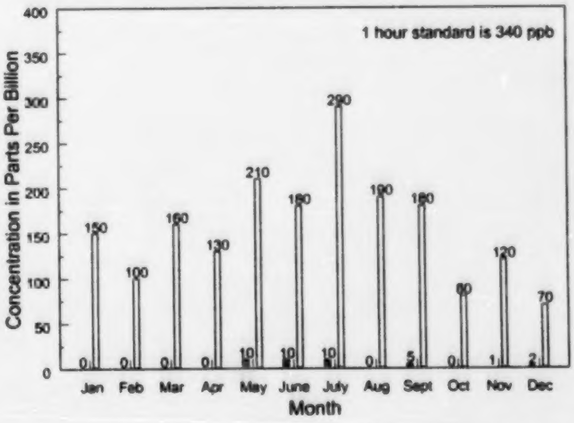
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1997

NB Power Belledune - Madran

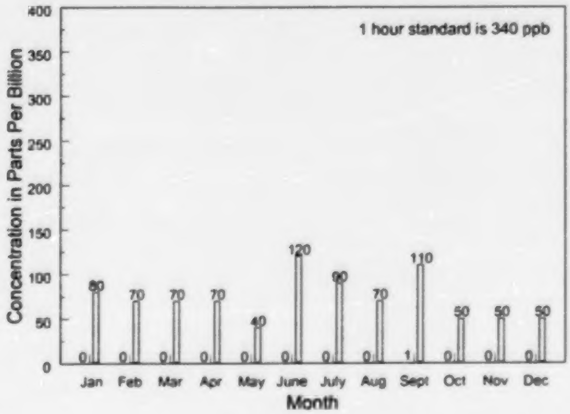


Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

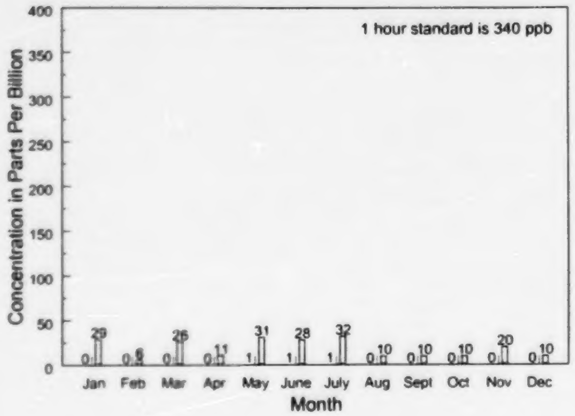
NB Power Belledune - Municipal Hall



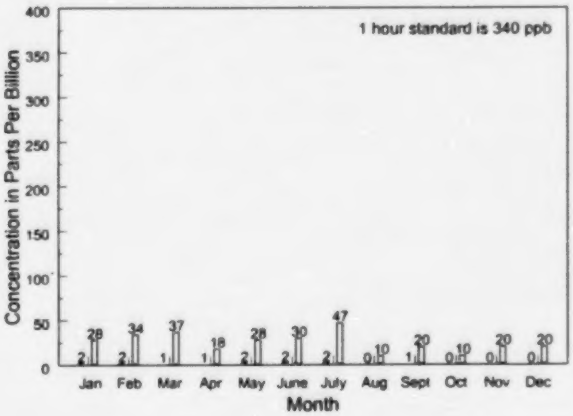
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Belledune - Pointe-Verte



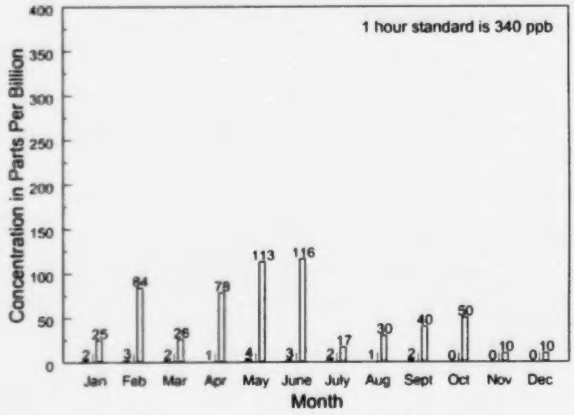
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Carleton



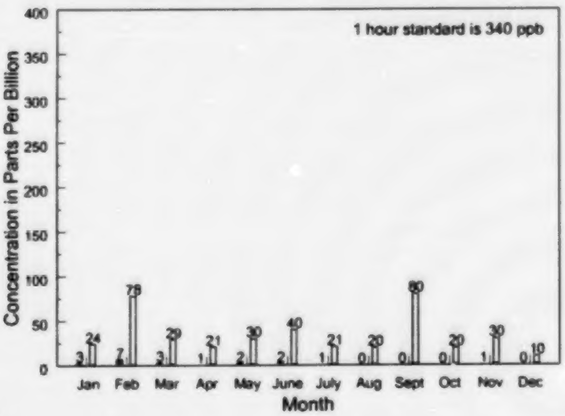
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Charlo



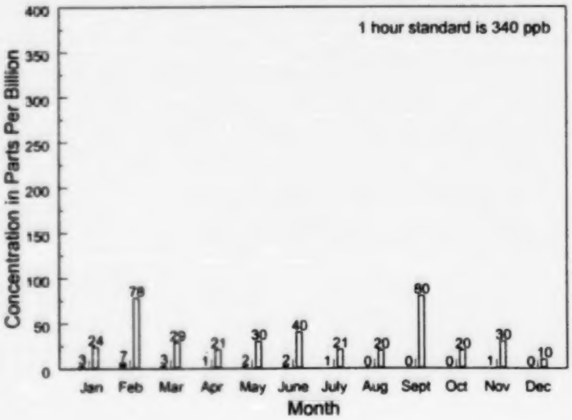
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Bayview



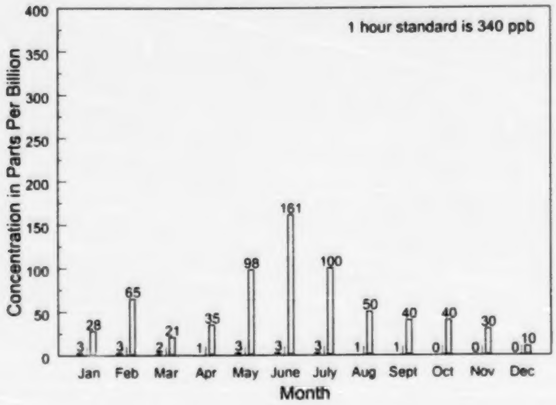
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Dalhousie Tower



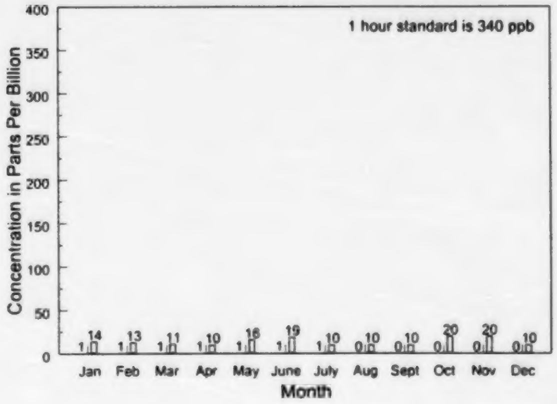
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Dalhousie Tower



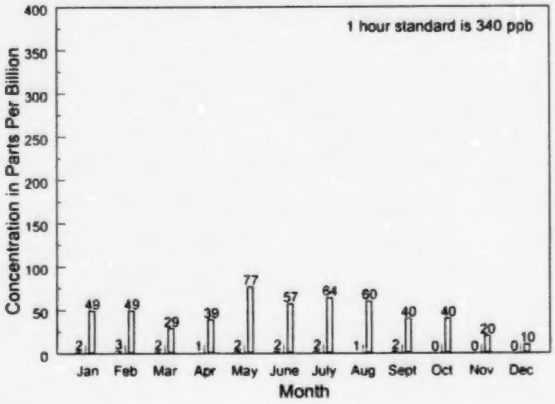
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Mobile



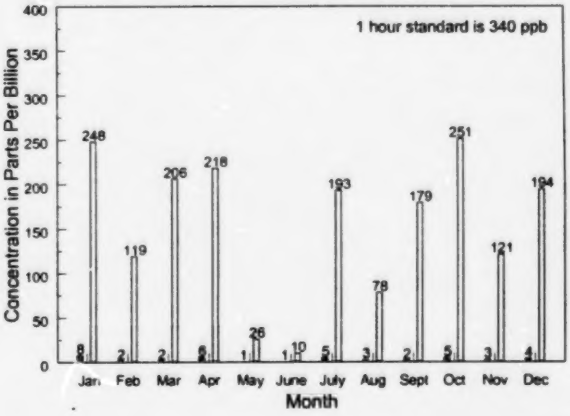
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Pointe-a-la-Garde



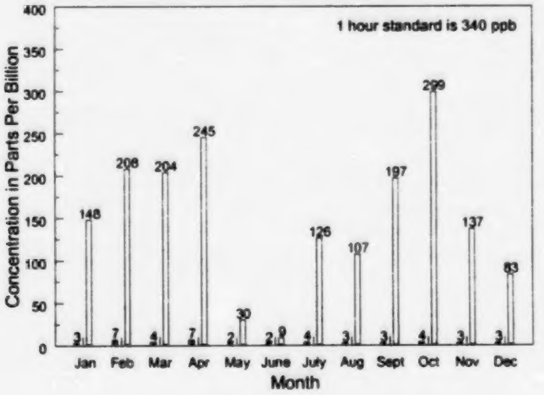
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Dalhousie - Point la Nim



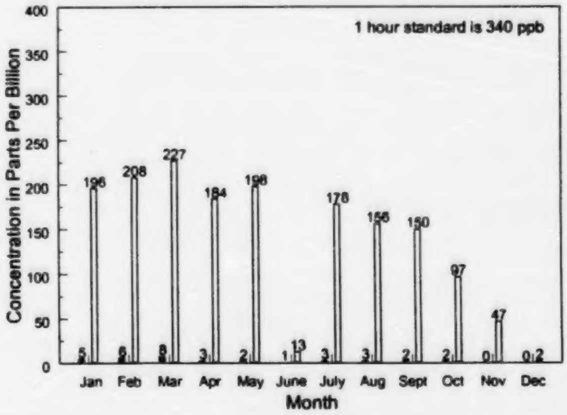
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Grand Lake - Bailey Point



Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Grand Lake - Cox Point

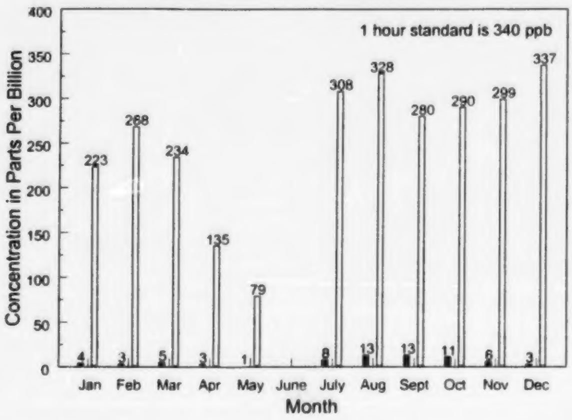


Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999
NB Power Grand Lake - Flowers Cove



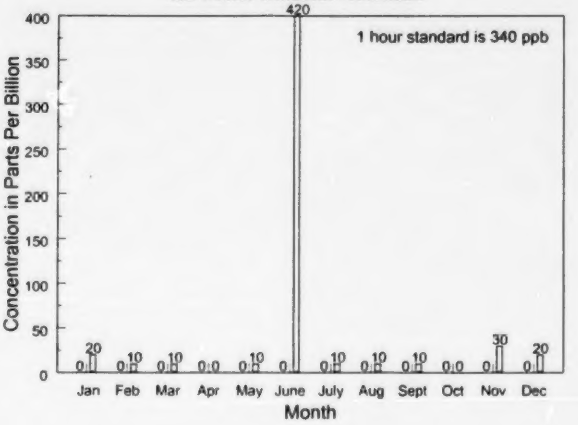
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

NB Power Grand Lake - Newcastle Centre



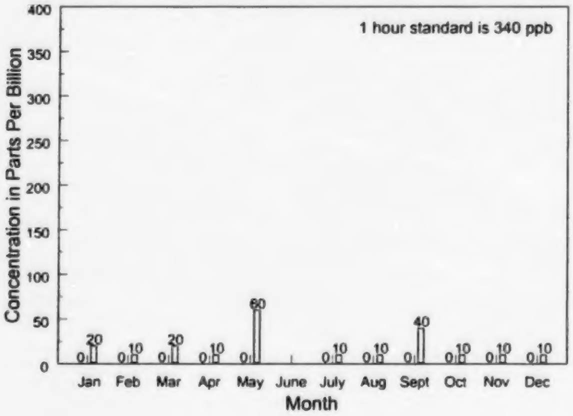
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

NB Power Millbank - Rockcliff



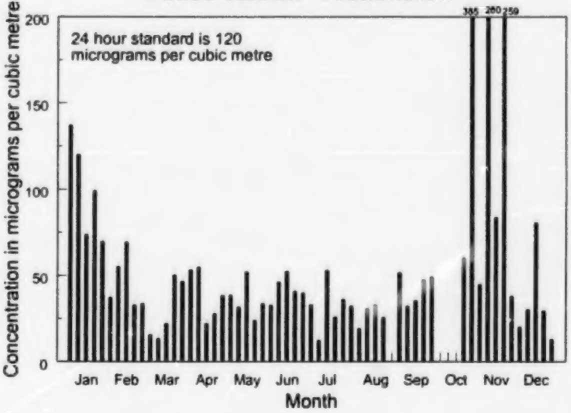
Monthly Average & Maximum One Hour Values of Sulphur Dioxide in 1999

NB Power Millbank - Lower Newcastle



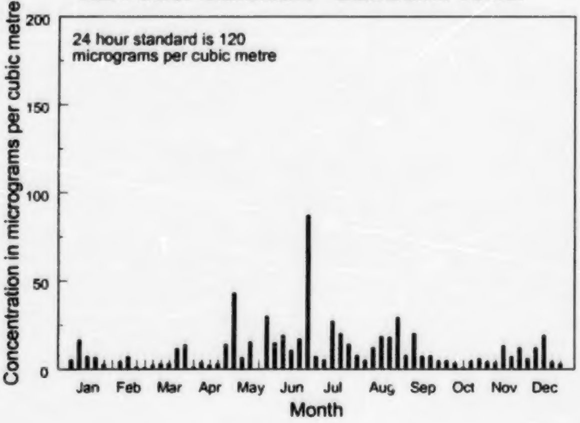
Daily TSP for 1999

Police Station - Fredericton



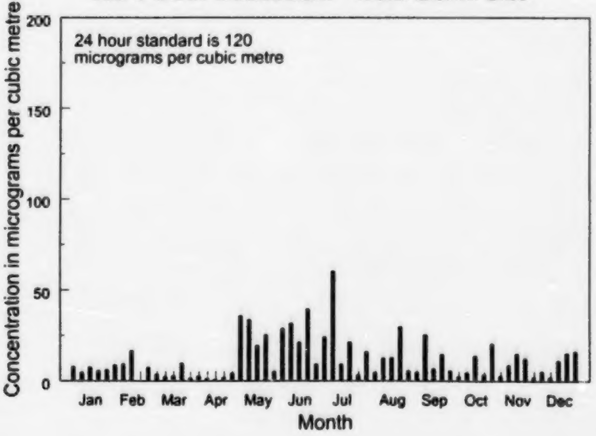
Daily TSP for 1999

NB Power Dalhousie - Dalhousie Tower



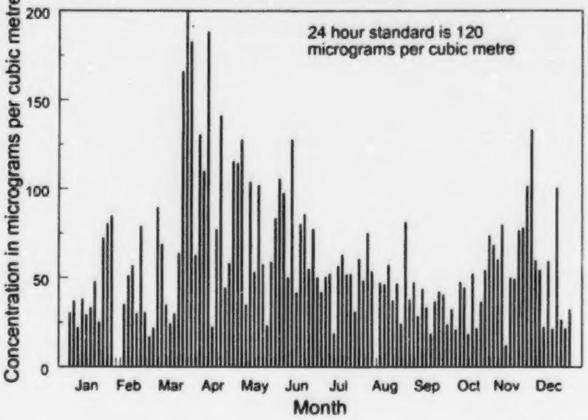
Daily TSP for 1999

NB Power Dalhousie - Coal Berm Site



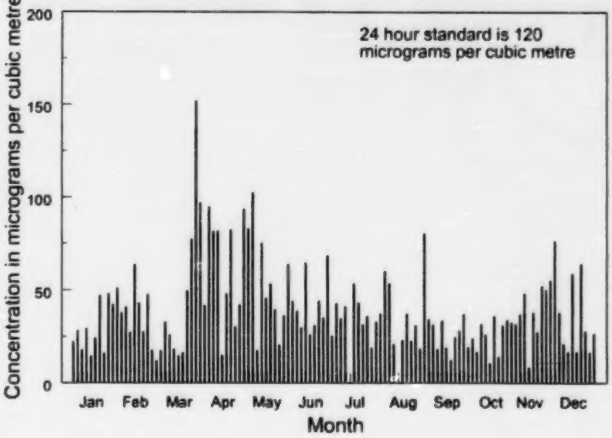
Daily TSP for 1999

Fraser - Cormier


24 hour standard is 120 micrograms per cubic metre

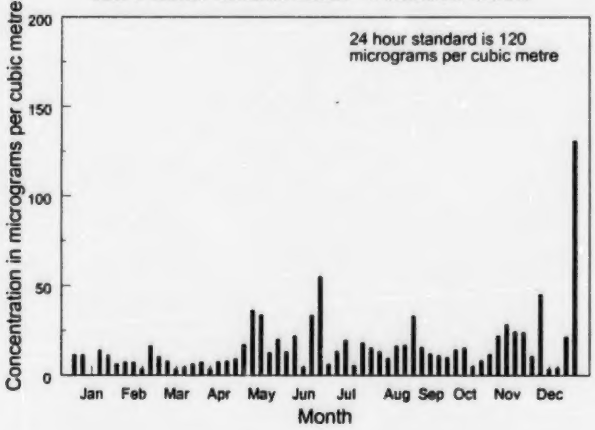
Daily TSP for 1999

Fraser - Sacred Heart


24 hour standard is 120 micrograms per cubic metre

Daily TSP for 1999

NB Power Grand Lake - Flowers Cove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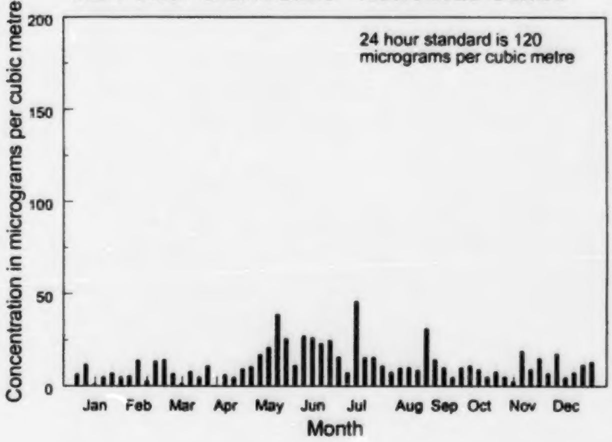
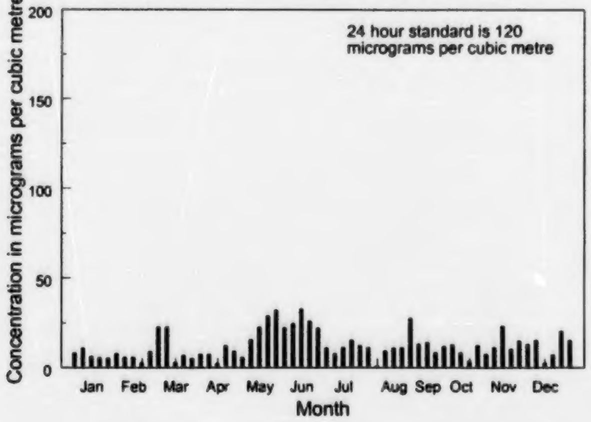
Daily TSP for 1999

NB Power Grand Lake - Newcastle Centre


24 hour standard is 120 micrograms per cubic metre

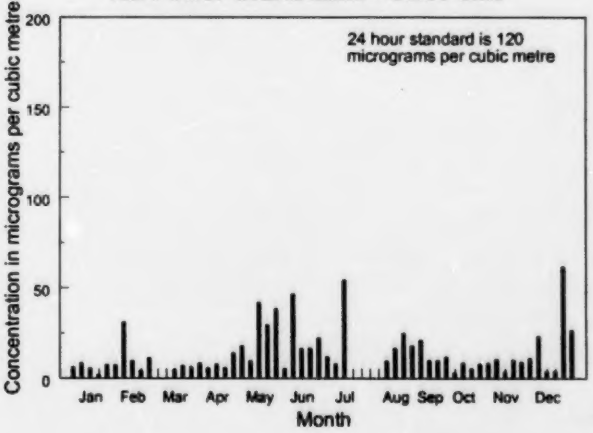
Daily TSP for 1999

NB Power Grand Lake - Bailey Point


24 hour standard is 120 micrograms per cubic metre

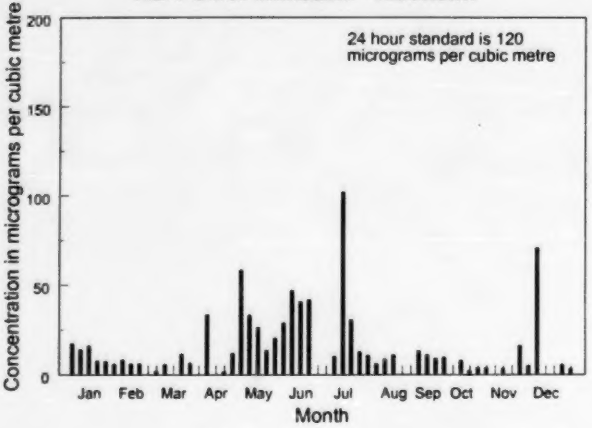
Daily TSP for 1999

NB Power Grand Lake - Cox Point


24 hour standard is 120 micrograms per cubic metre

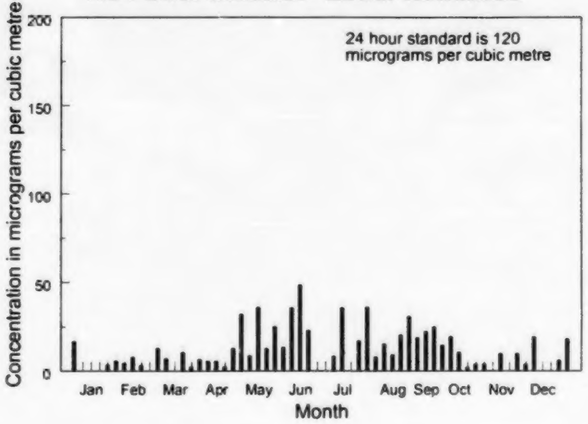
Daily TSP for 1999

NB Power Millbank - Rockcliff



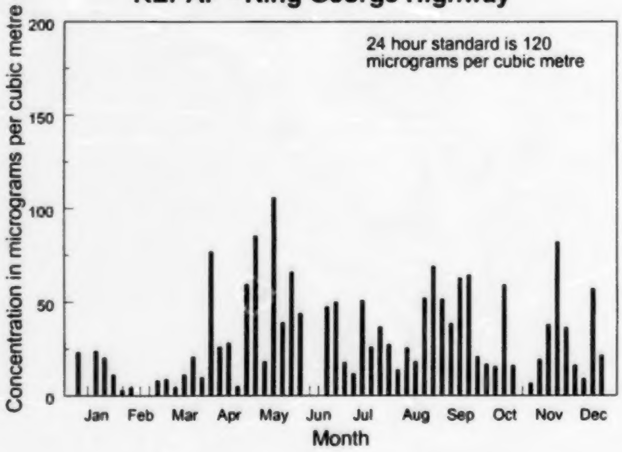
Daily TSP for 1999

NB Power Millbank - Lower Newcastle



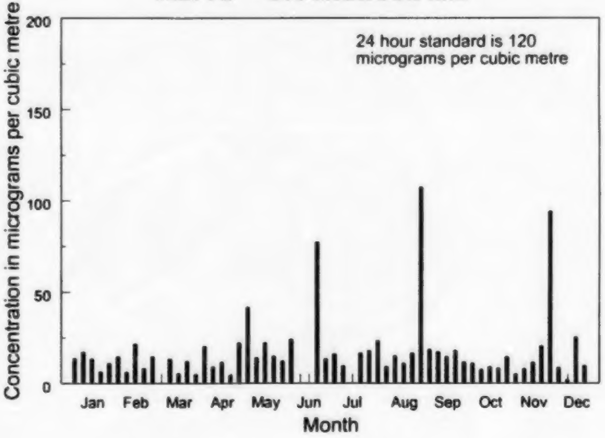
Daily TSP for 1999

REPAP - King George Highway



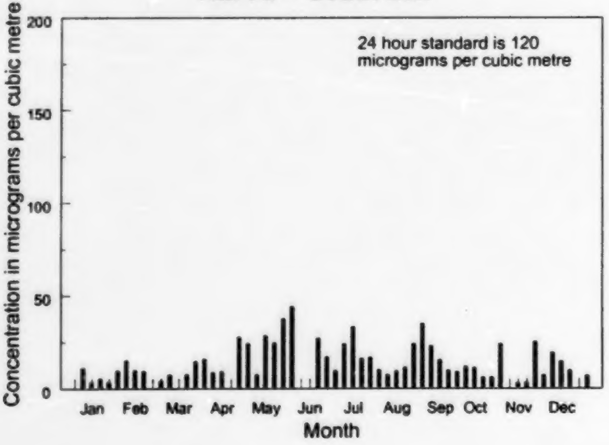
Daily TSP for 1999

REPAP - Groundwood Mill



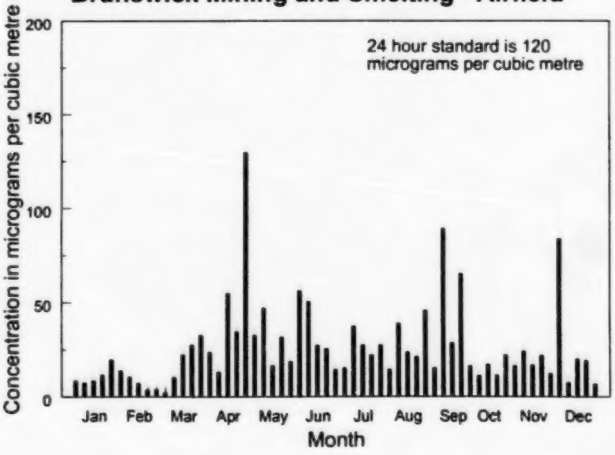
Daily TSP for 1999

REPAP - South Esk



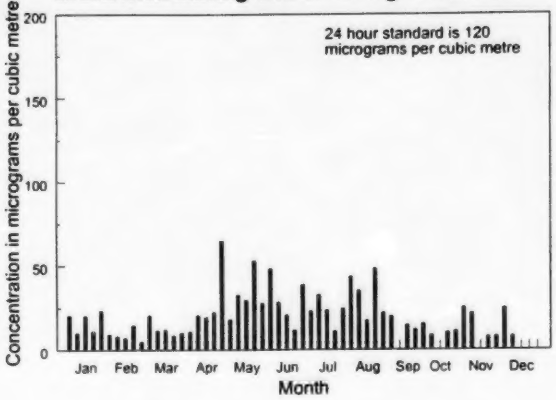
Daily TSP for 1999

Brunswick Mining and Smelting - Airfield



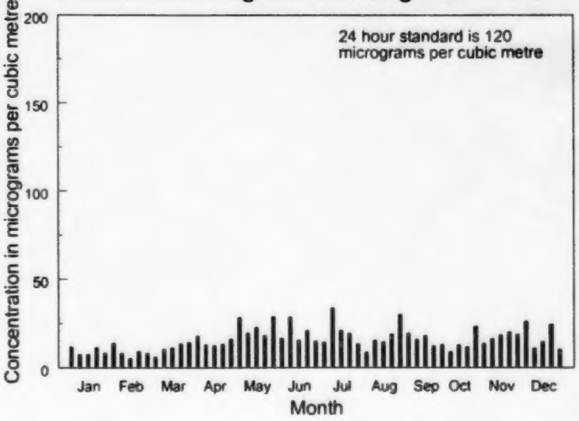
Daily TSP for 1999

Brunswick Mining and Smelting - Townsite



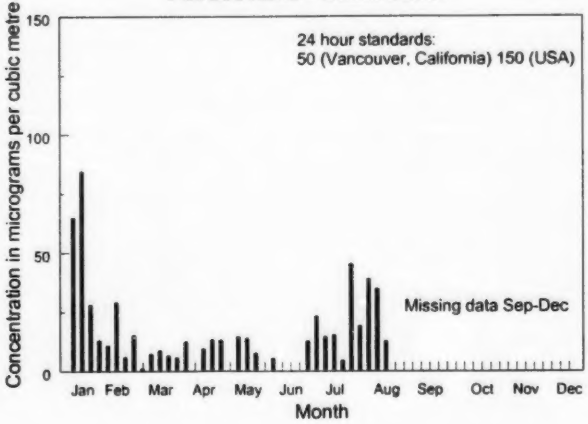
Daily TSP for 1999

Brunswick Mining and Smelting - Chalmers



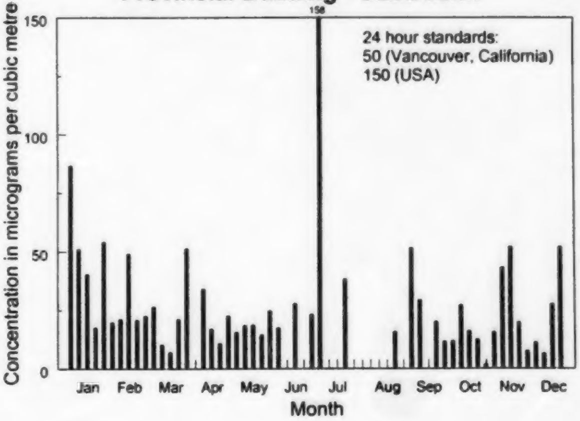
Daily PM10 for 1999

Forest Hills - Saint John



Daily PM10 for 1999

Provincial Building - Saint John



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